

Biogeochemistry in Choptank in 1986-1987 and 1991-2000

Modeling Workgroup October 2026 Quarterly Review

October 28, 2026

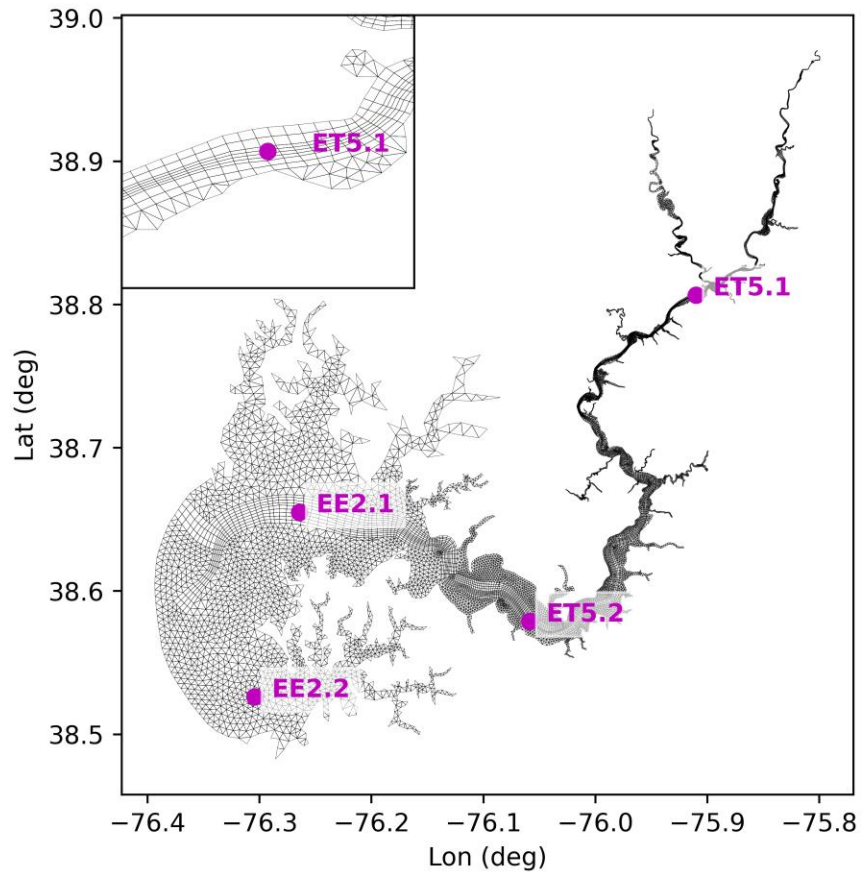
Jeremy Testa, William Nardin, Elizabeth North, Larry Sanford, Jiabi Du, Haodong Xu, Arnob Ghosh

Outlines

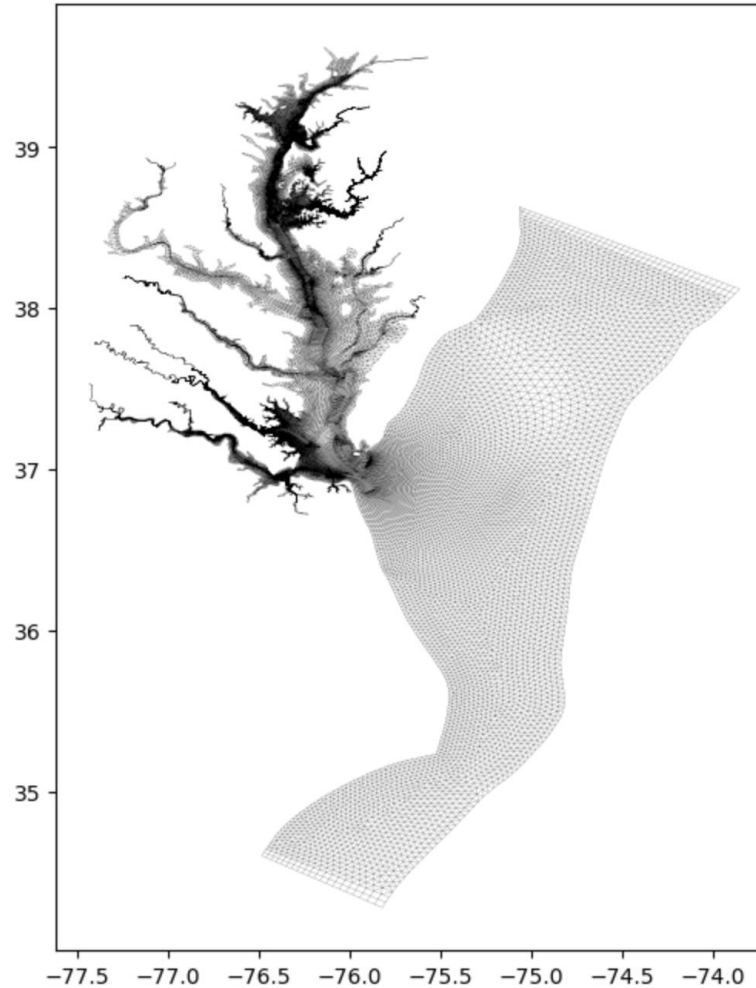
- Part 1: hydrodynamic and upwelling
- Part 2: biogeochemical modeling and sensitivity test on river nutrient inputs

Coupling with main bay

Choptank model



Main bay model



Finner resolution grid
in Choptank River

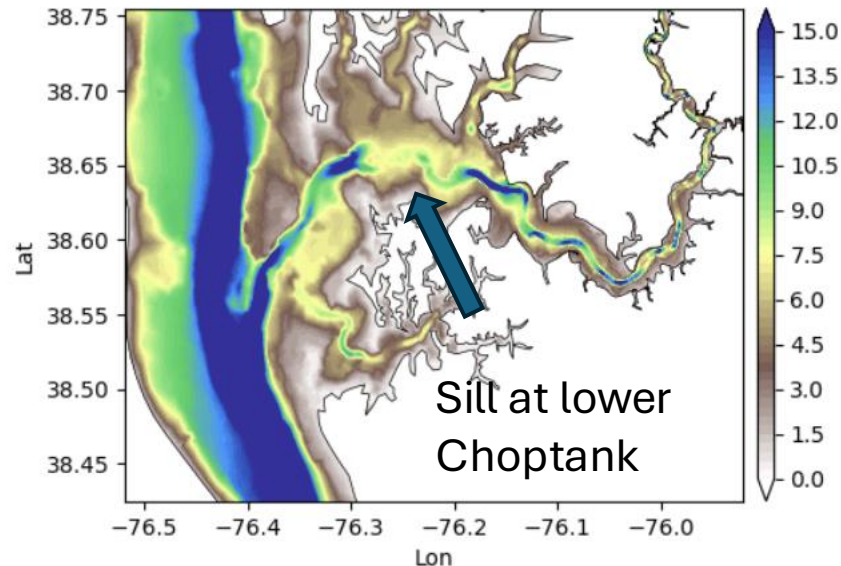
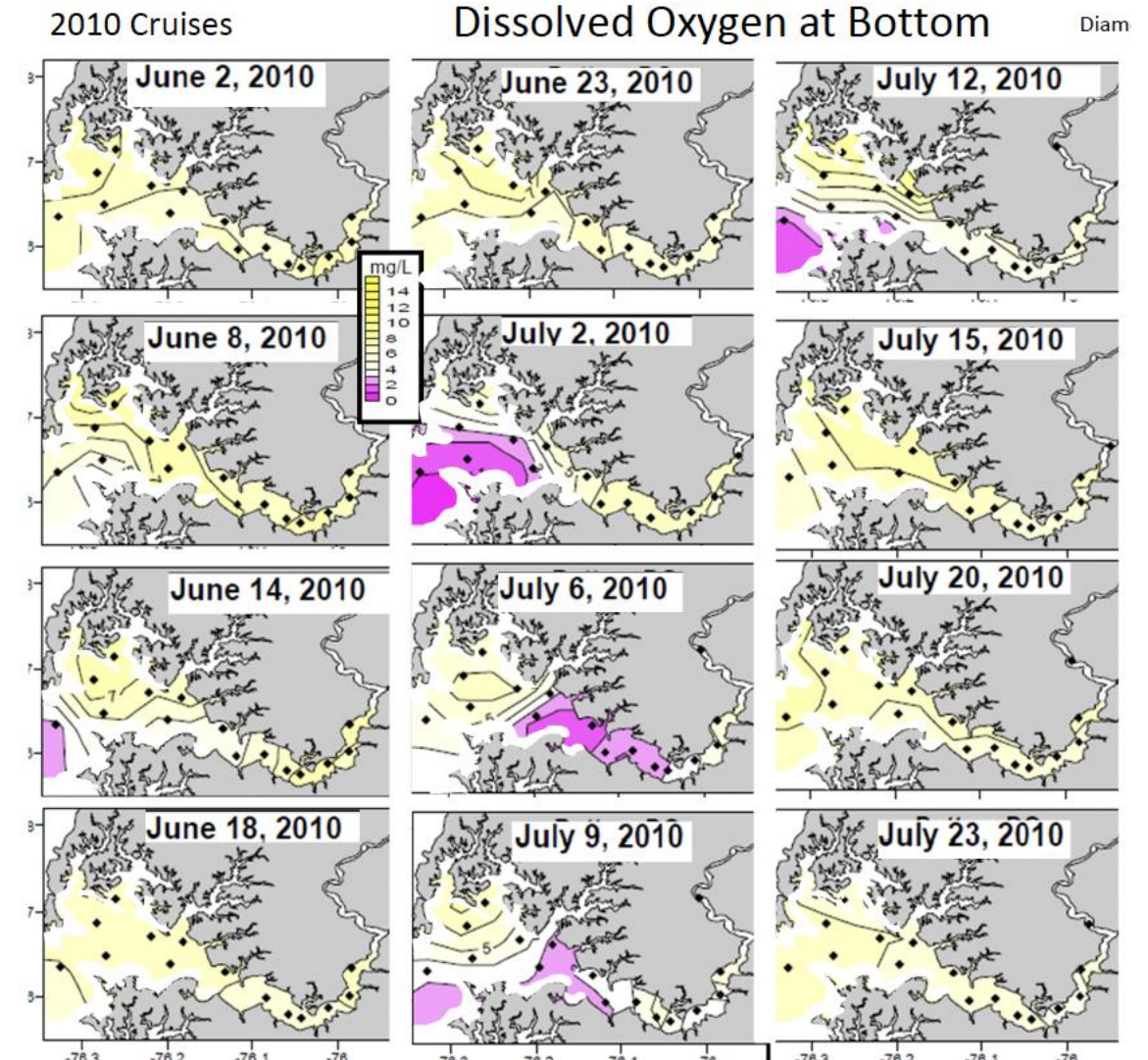
Stratification and salt intrusion is critically important for hypoxia

❑ Contribution from local process

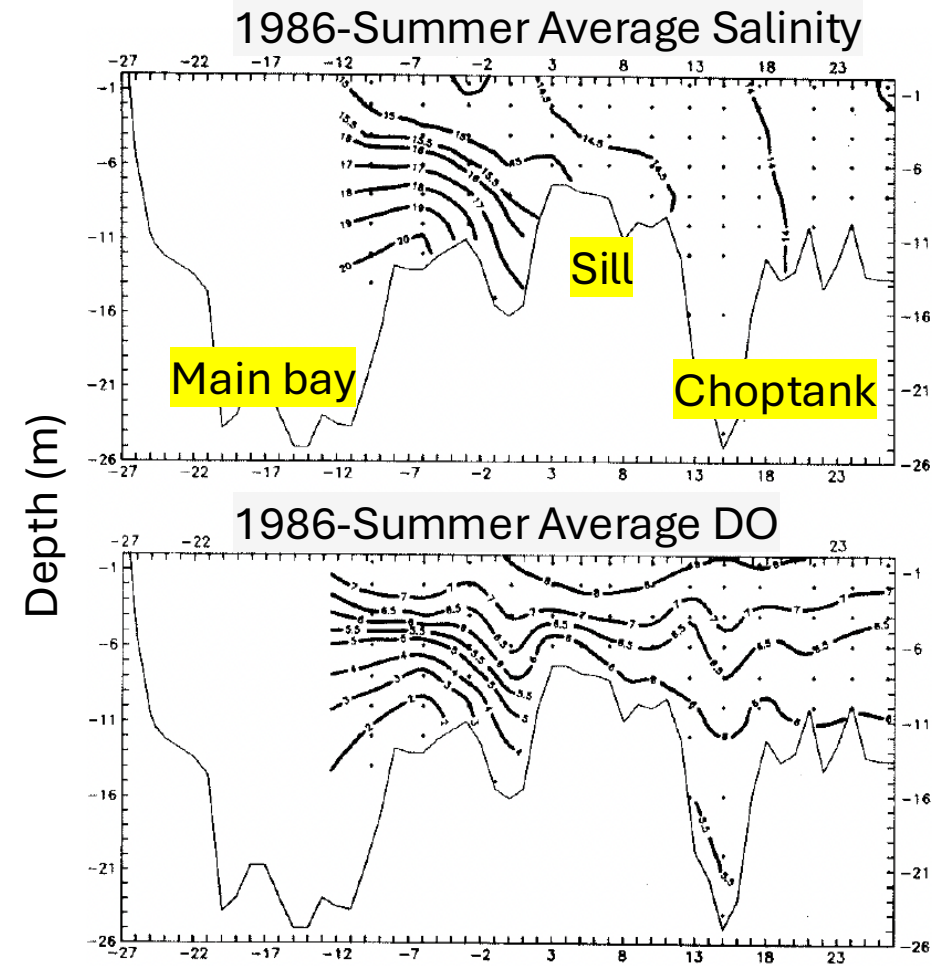
❑ Hypoxic water from main bay

Example in July 2010

- Notable hypoxic water moved from main bay.
- The hypoxic water moved over the sill and stay in the lower Choptank Estuary.



Upwelling of bottom main bay water



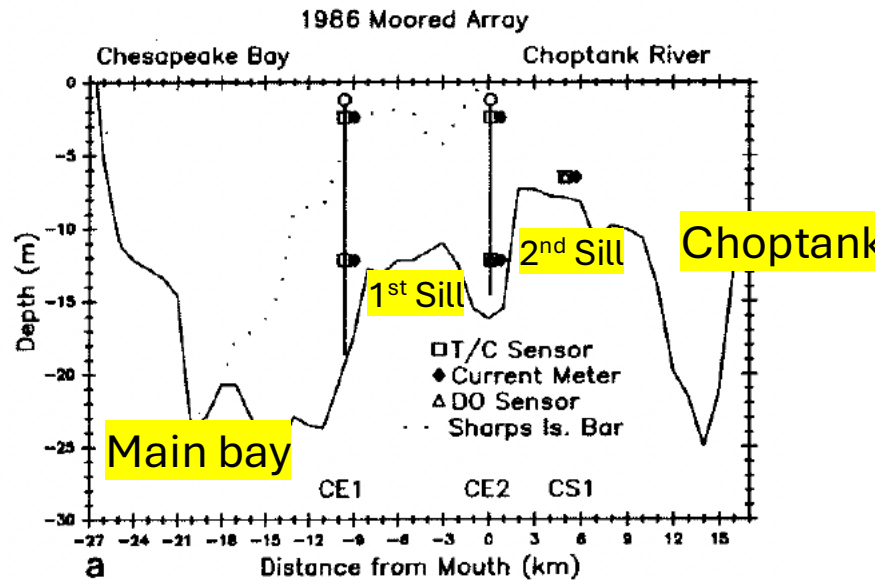
Influence of sill:

Sill effectively blocks intrusion of main bay bottom water (salty and low DO)

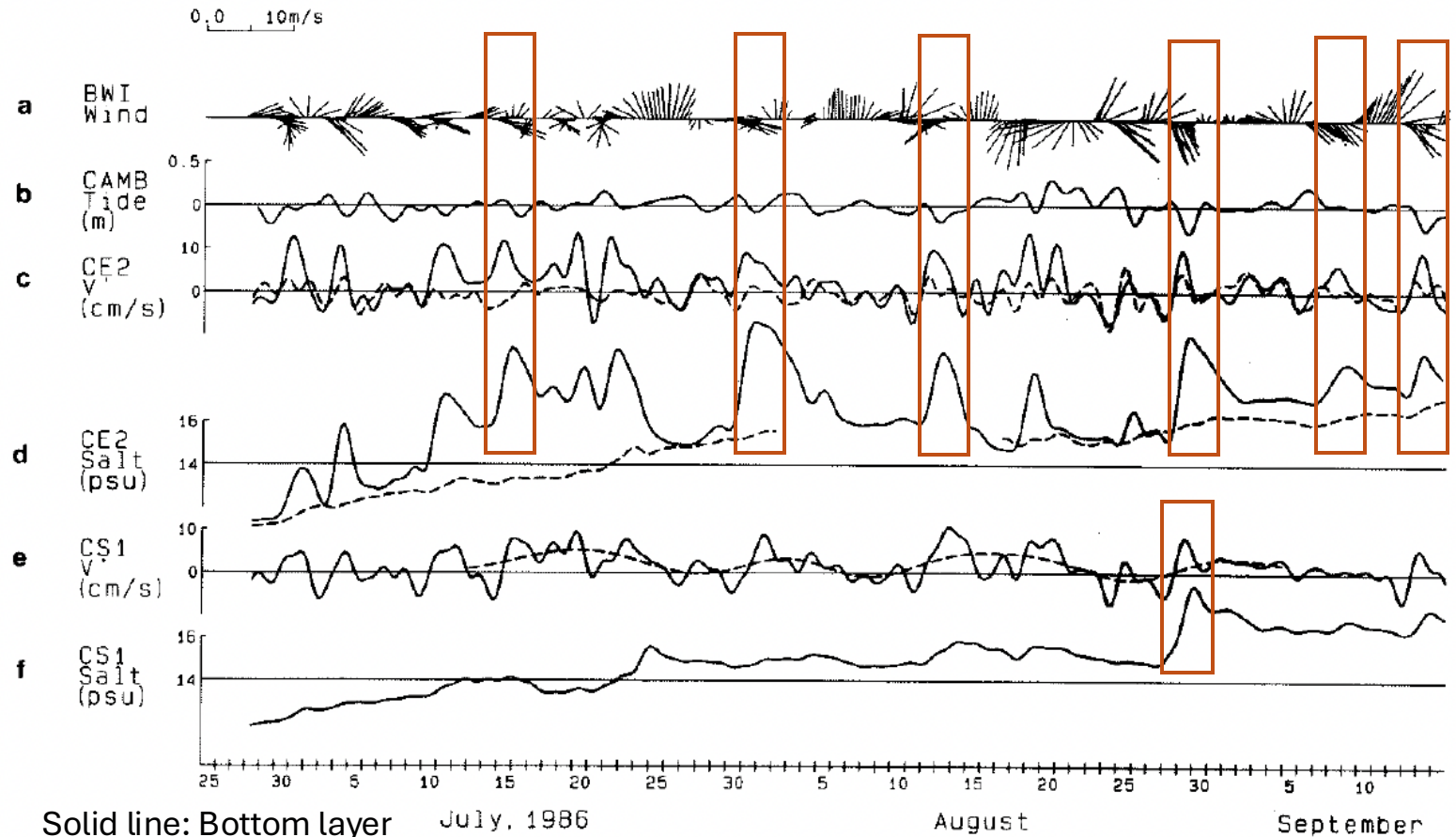
“There is high inverse spatial correlation between averaged salt and average DO in the lower layer” - Sanford & Boicourt, 1990

Sanford and Boicourt, 1990

Upwelling/intrusion of bottom main bay water



- “Intrusions are always preceded by a southward wind pulse”
- Southward wind pulse led to landward bottom velocity and bottom salinity increase.
- More frequent intrusions happened at station CE2 (before the first sill) than at station CS1 (before the second sill)

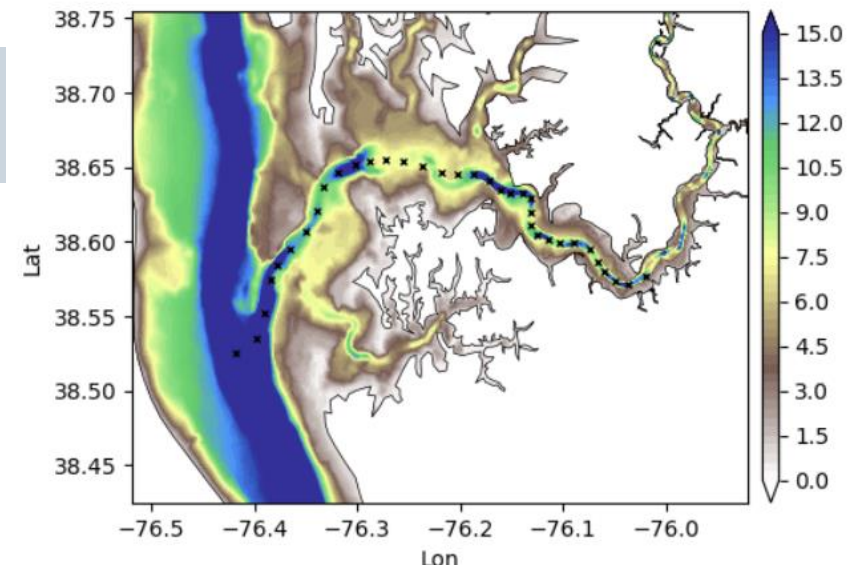
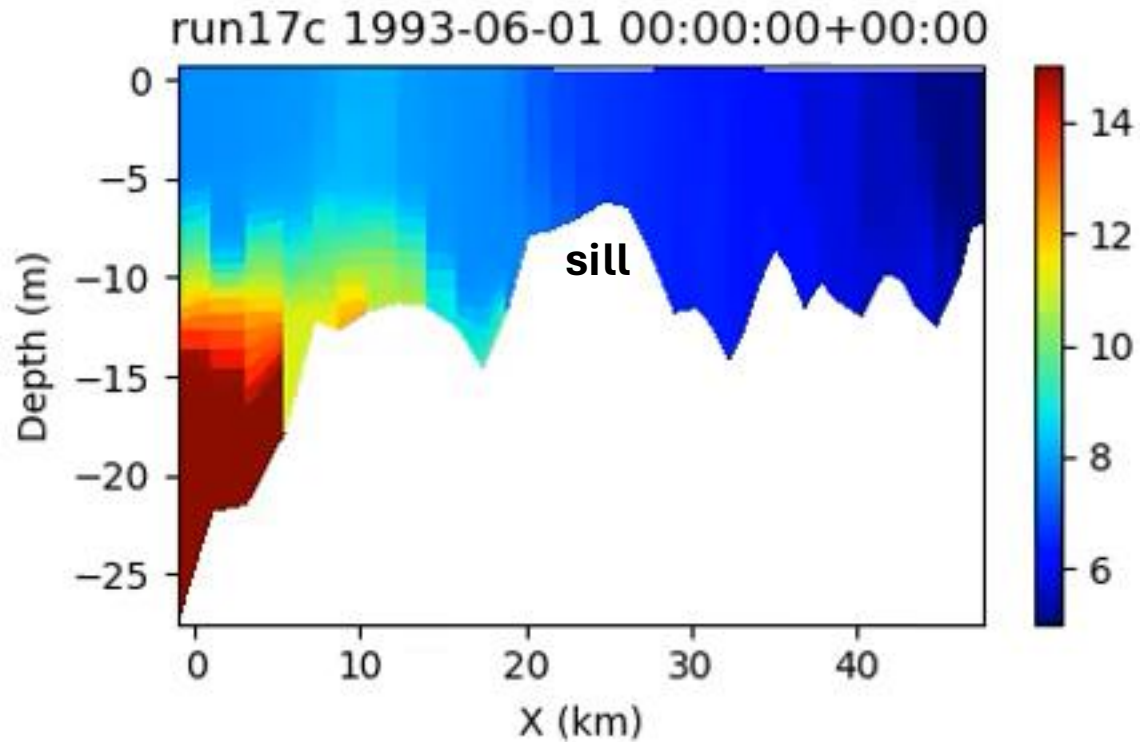
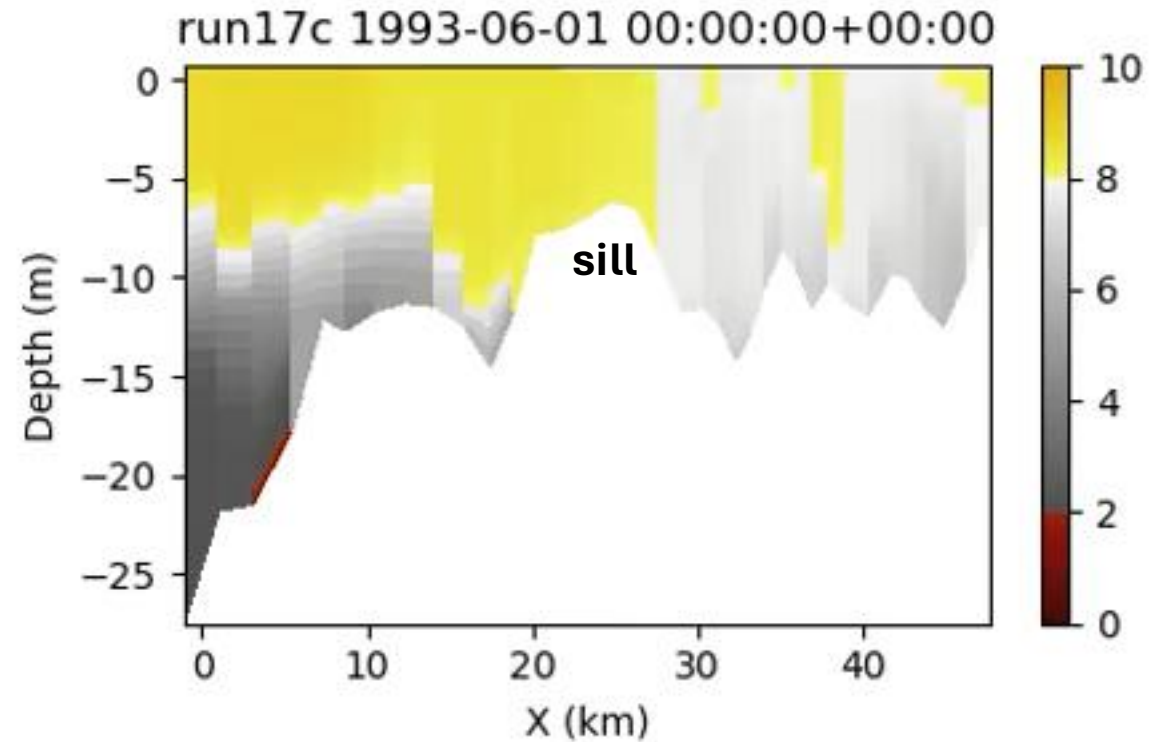


Sanford and Boicourt, 1990

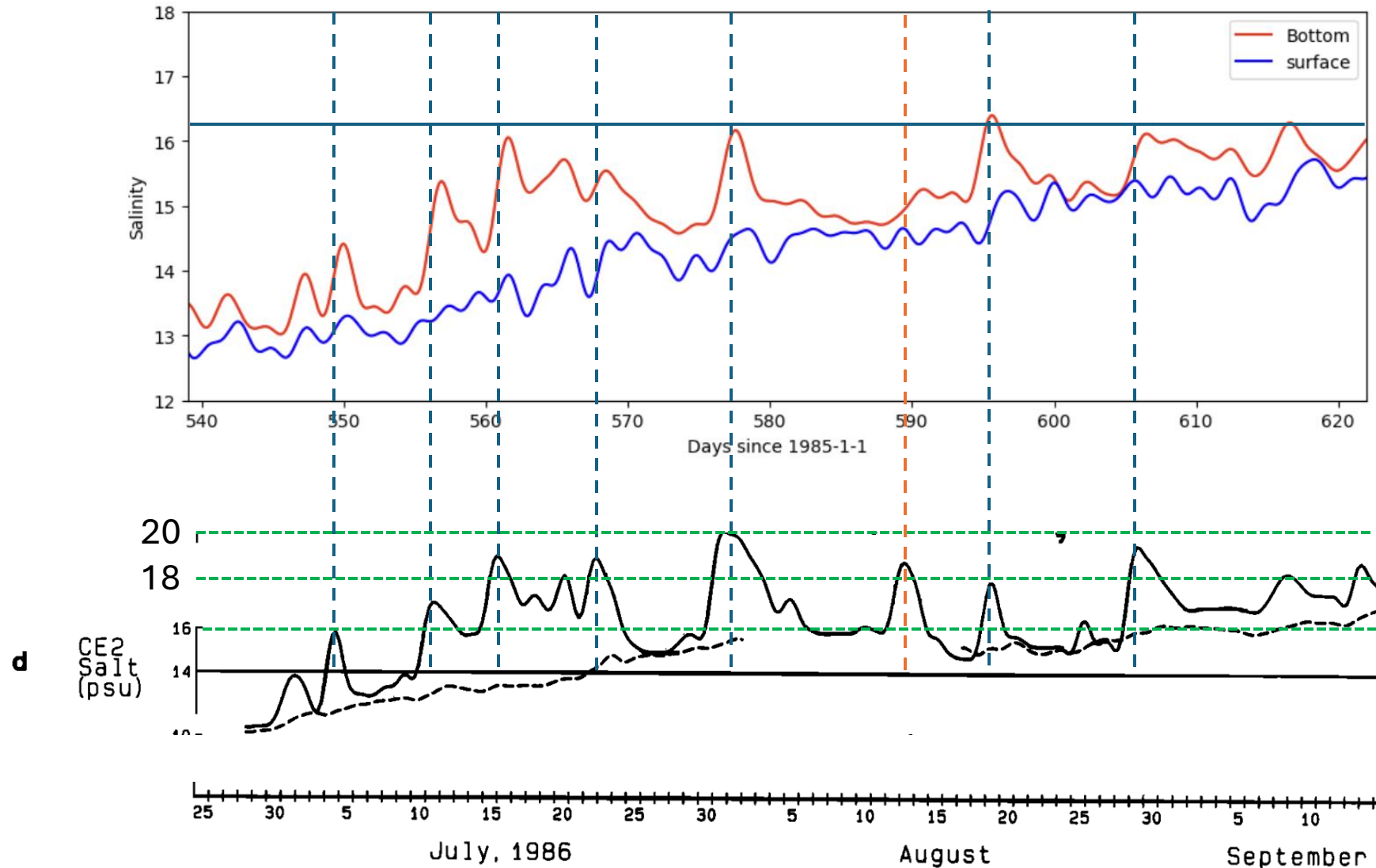
Main bay water intrusion

1993-June

Hypoxic water from main bay did not spill over the sill.



Salt intrusion and upwelling at CE2

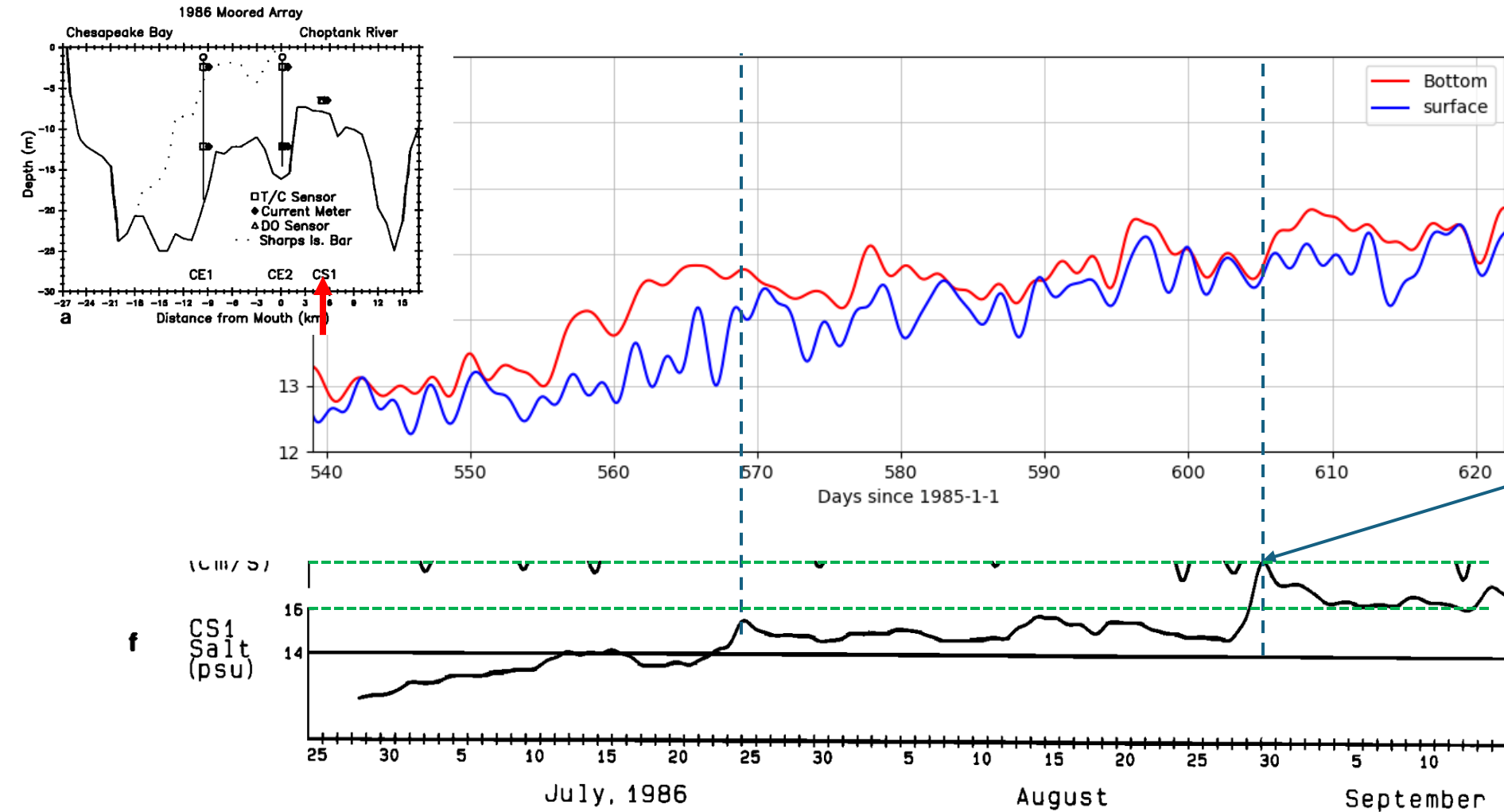


Salt intrusion events are well captured.

Magnitude of bottom salinity increase is less than observation.

Observed salinity reached 20; modeled salinity reached 16.5.

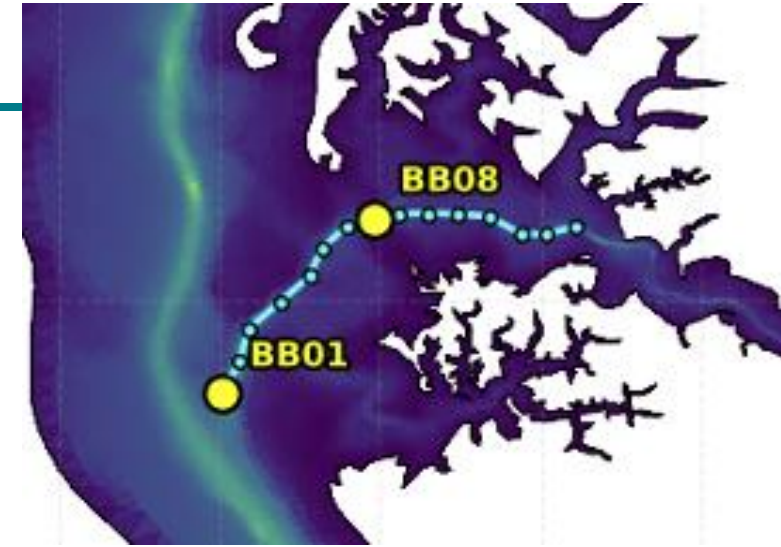
At CS1 (the second sill): modeled salinity has larger subtidal variability



Second notable salt intrusion (**bottom salinity** increase from 14 to 18) is not captured.

Again, increase of modelled salinity is less than observation.

Example: W_095 wind event and salinity response

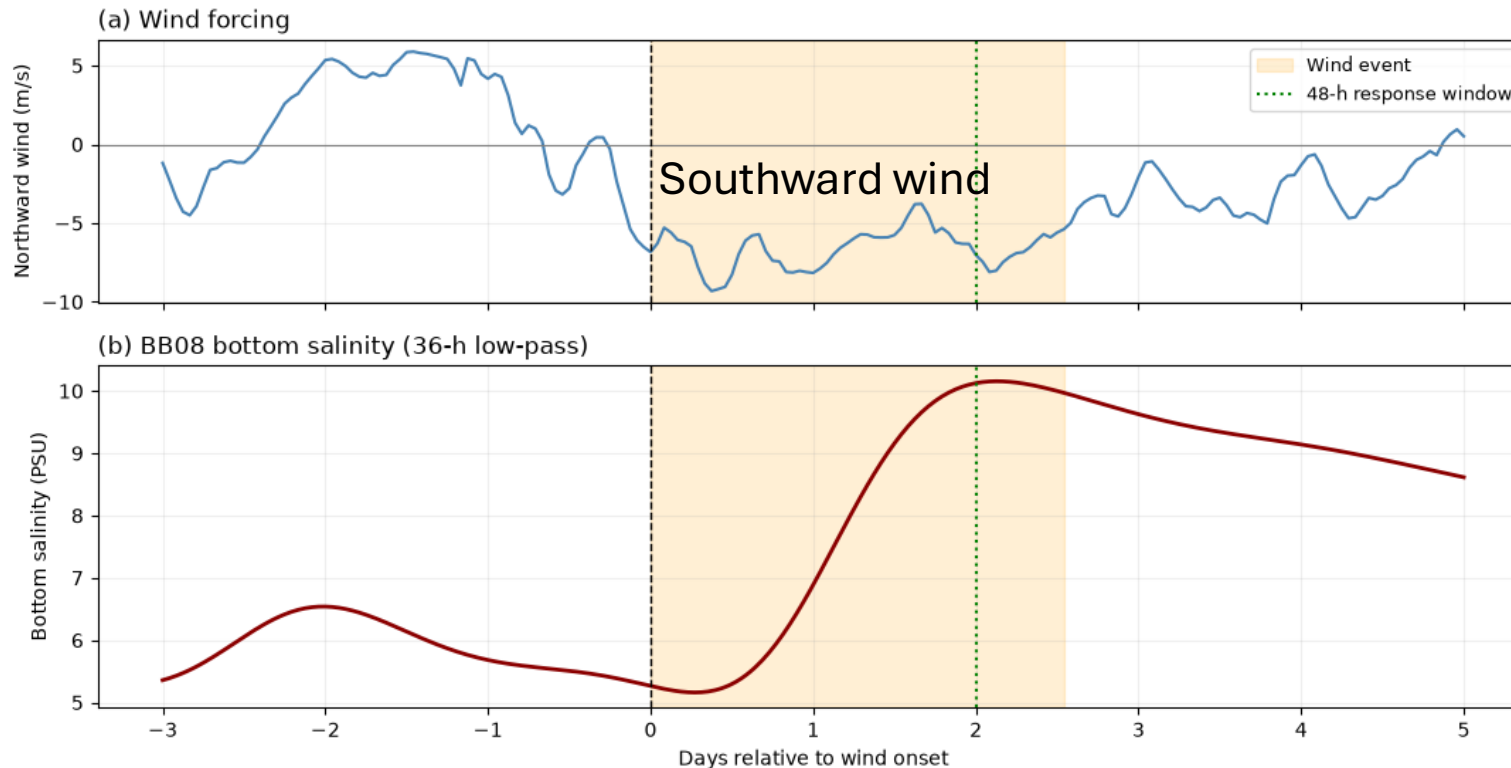


Southward wind

- > Ekman transport to west
- > upwelling
- > salt intrusion

Wind event #95 (17 May 1994)

Wind Event W_095: Salinity Response at BB08

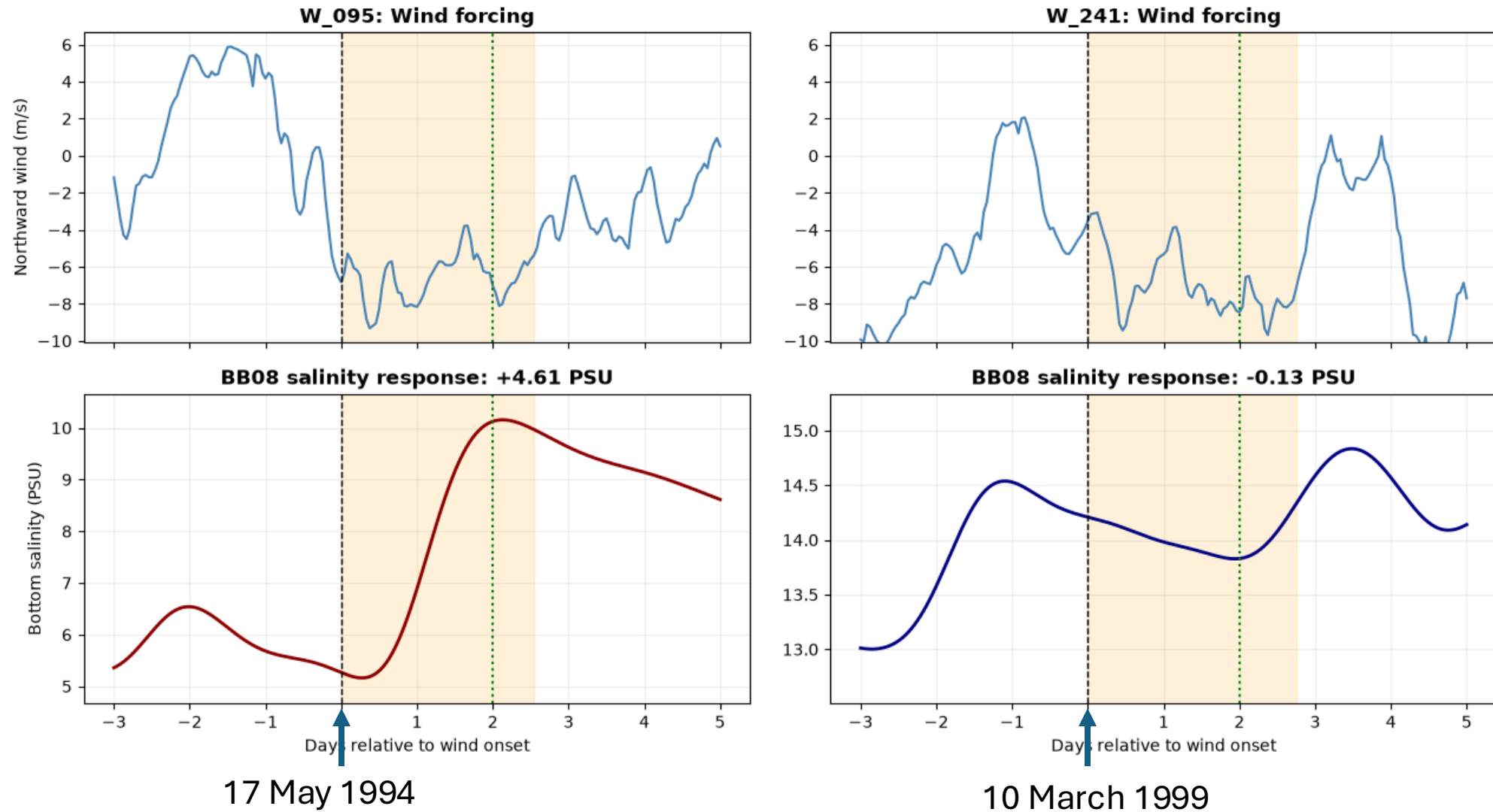


Wind event criterion

- Northward wind component ≤ -5 m/s (Southward), sustained for ≥ 6 hours

Similar winds, different salinity responses

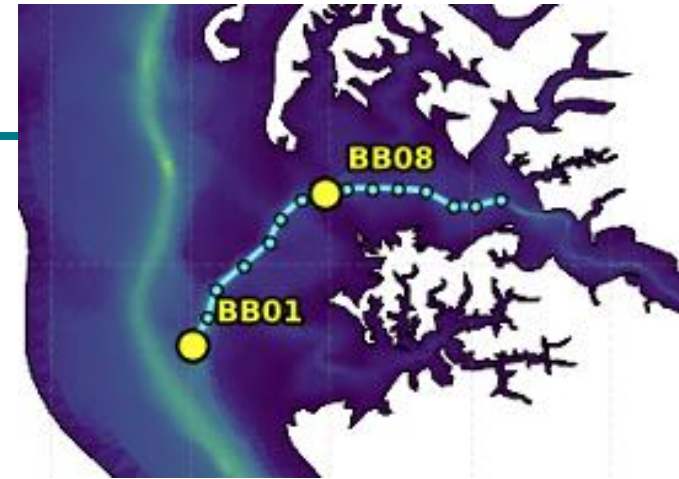
Contrasting Salinity Responses to Strong Southward Winds



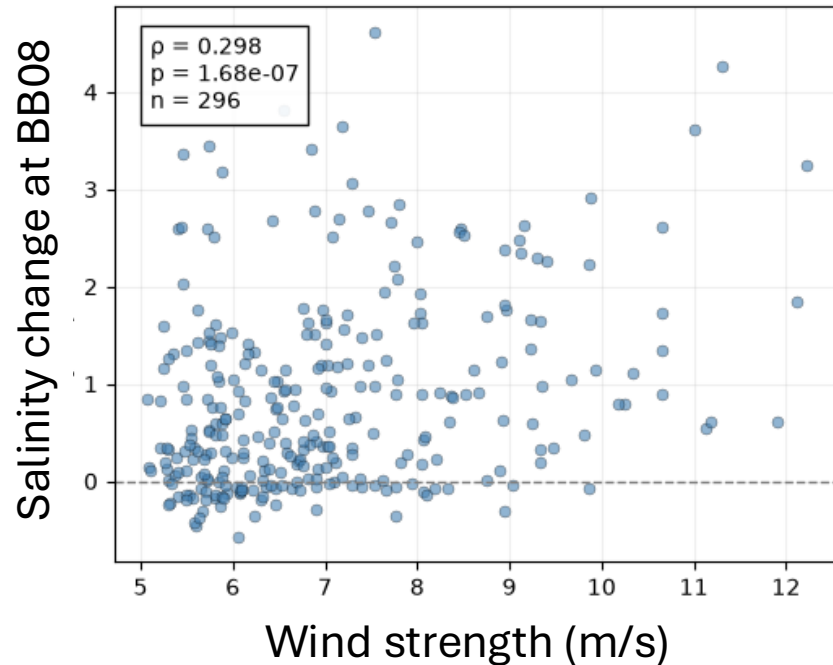
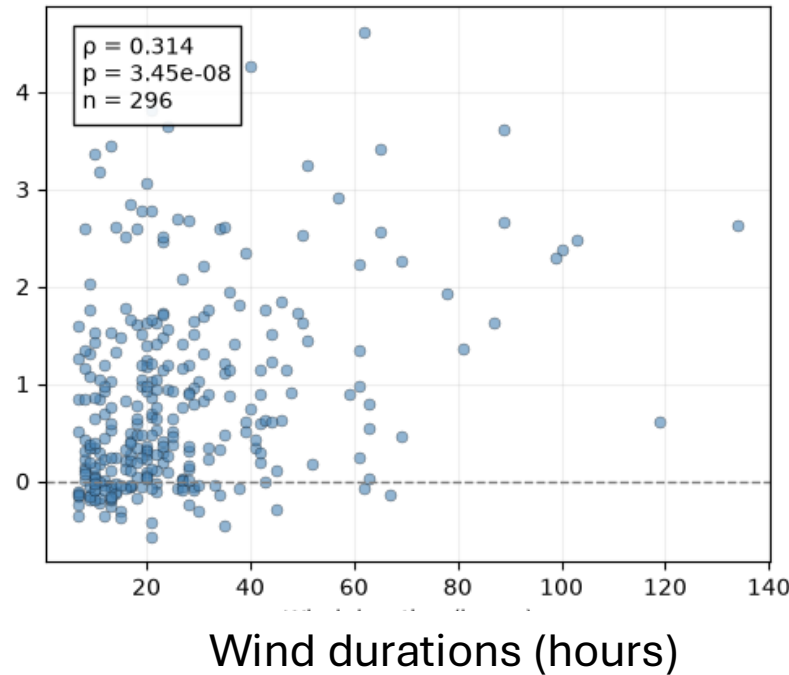
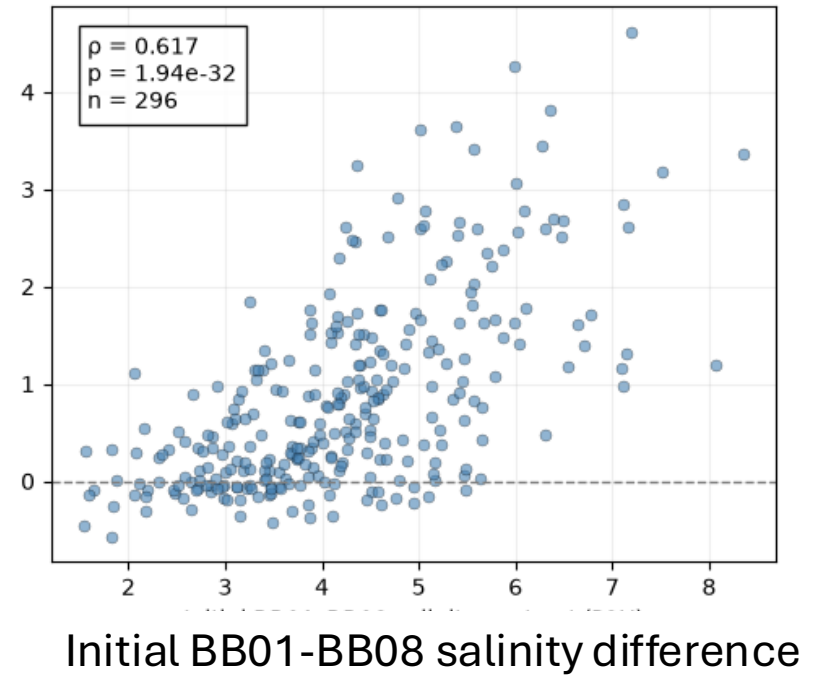
What controls the 48-hour salinity response?

296 southward wind events

It turns out the salinity gradient from main bay to Choptank matters.



Factors Associated with Wind-Event Salinity Response



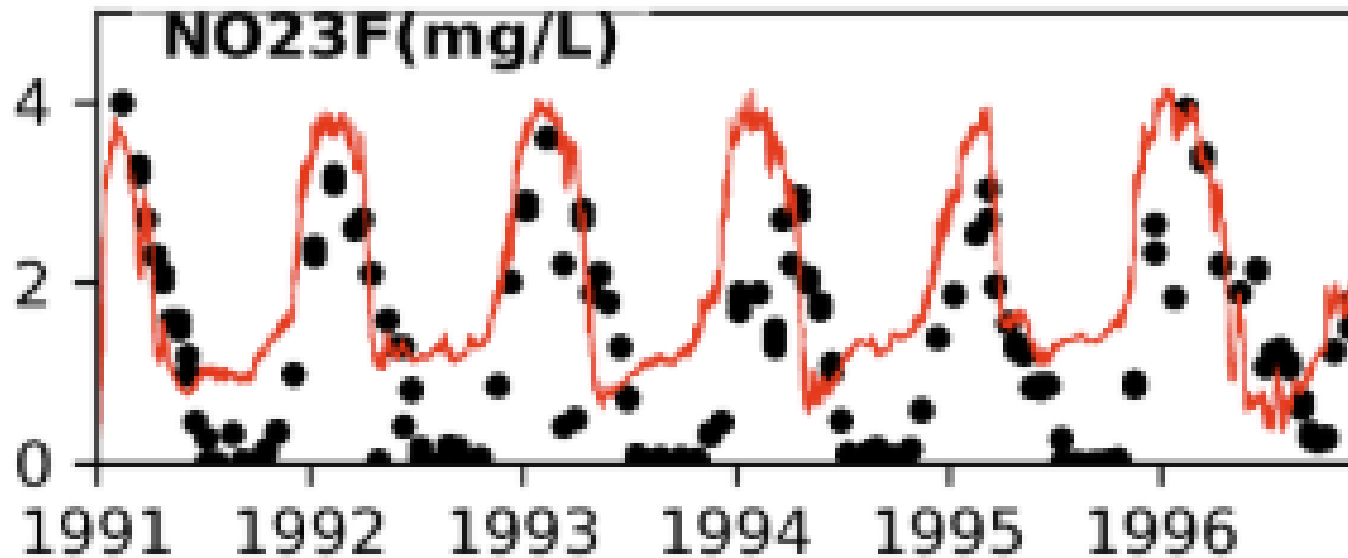
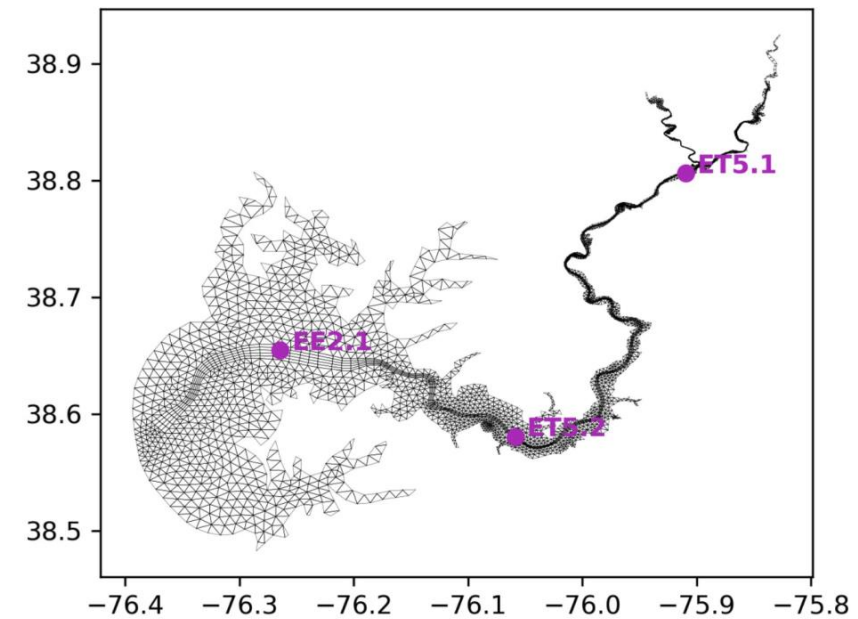
Key takeaways on hydrodynamic modelling

- Salt intrusion and upwelling are well simulated by SCHISM model.
- Southward wind does not necessarily lead to salt intrusion, depending on the salinity gradient from main bay and Choptank.
- Intrusion over the second sill needs additional effort and future investigation

Part 2: BGC sensitivity test

Why?

There is overestimation of NO₂₃ during summer.

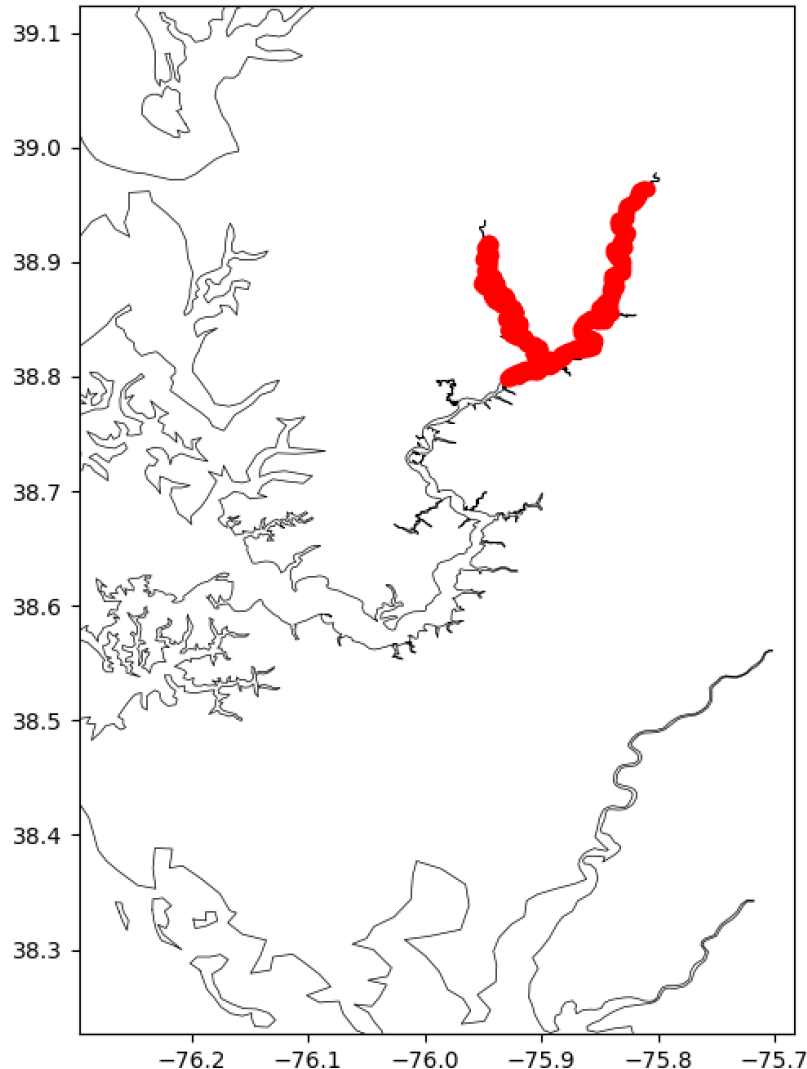
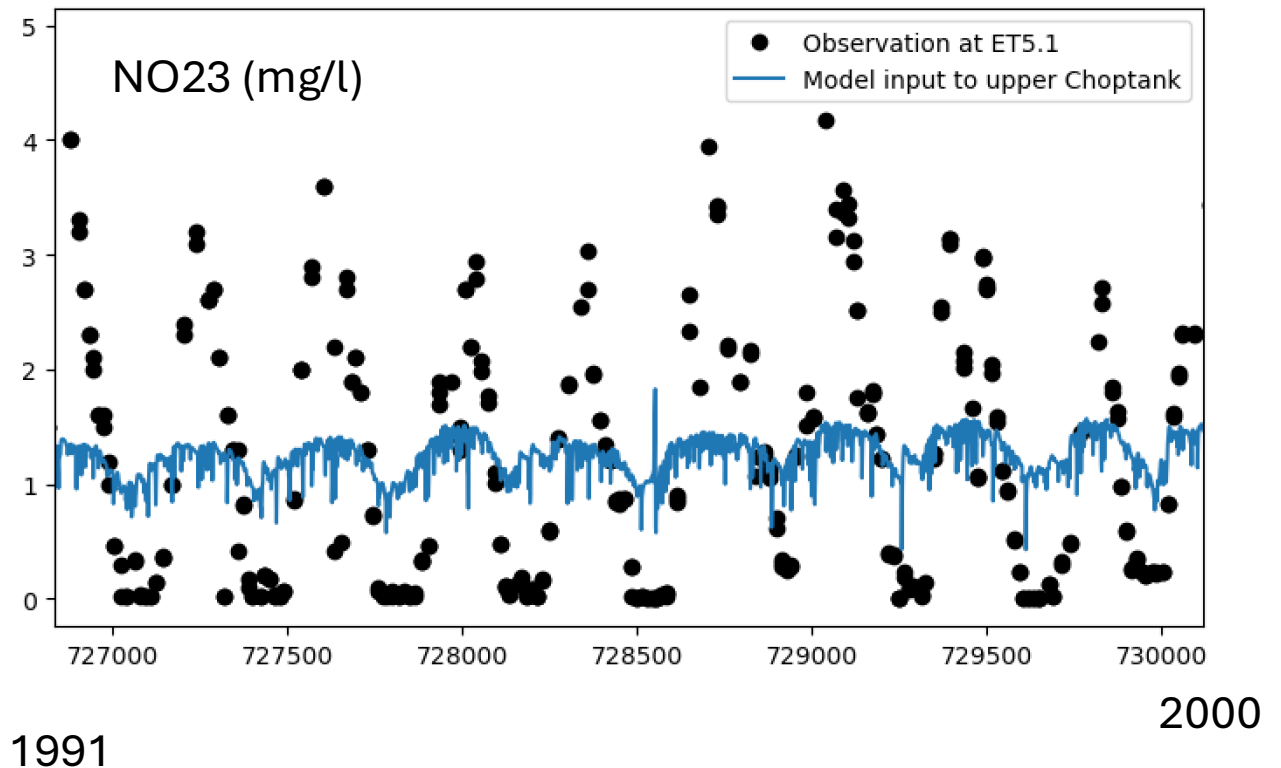


At station ET5.1

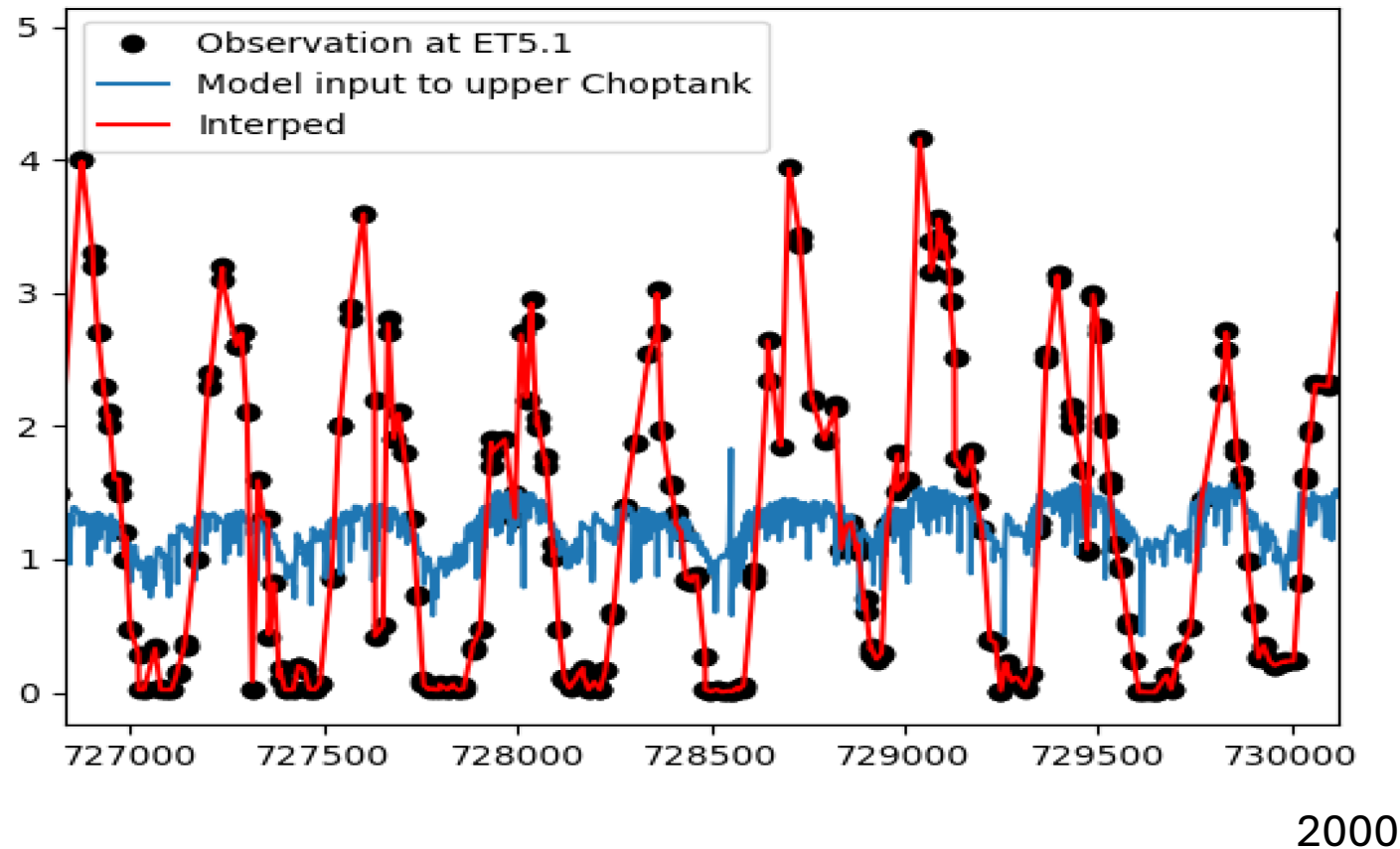
Is that because
of river inputs ?

Sensitivity test with different river input.

NO₂₃ (averaged over those point sources) from Watershed model output different from the observation at ET5.1.

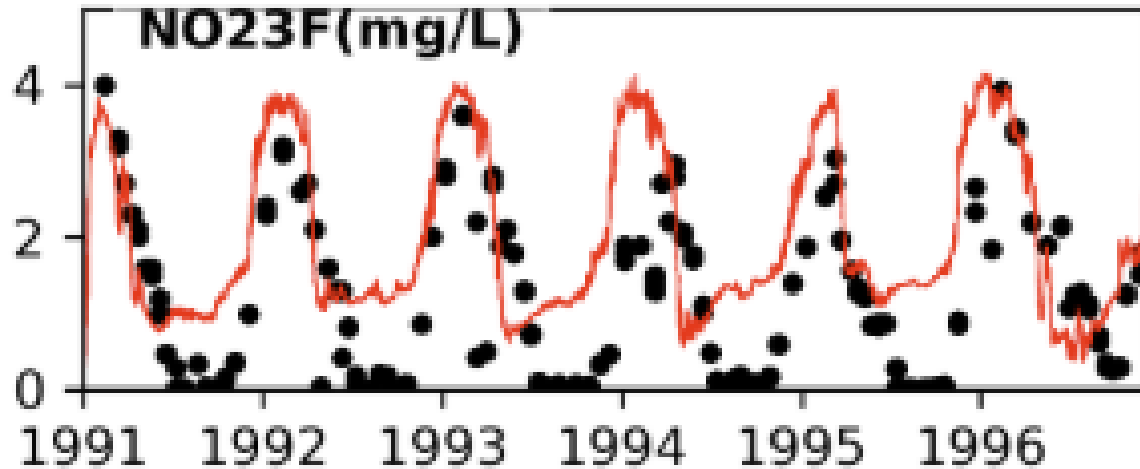


We changed the NO₂3 for those point sources based on observed value in the upstream

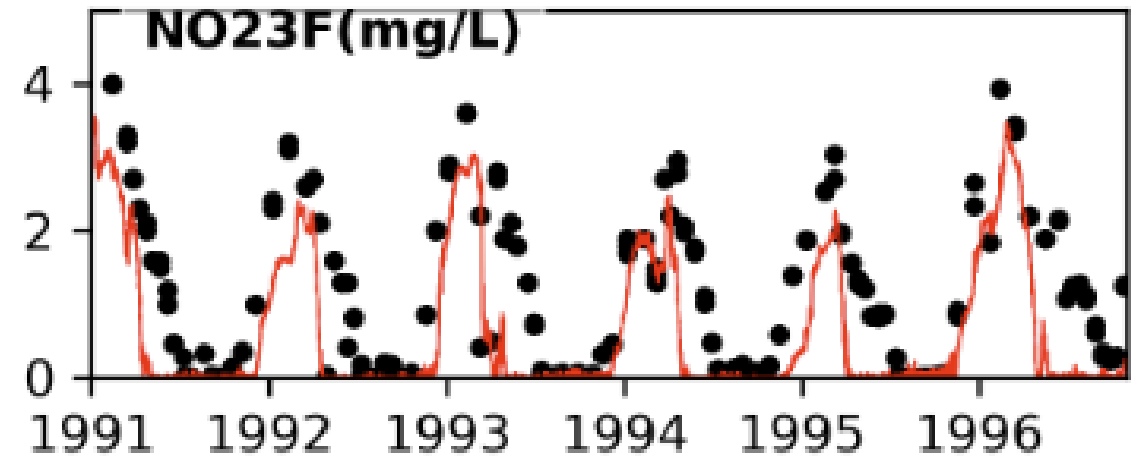


Difference in NO₂3 at station ET5.1

run17c

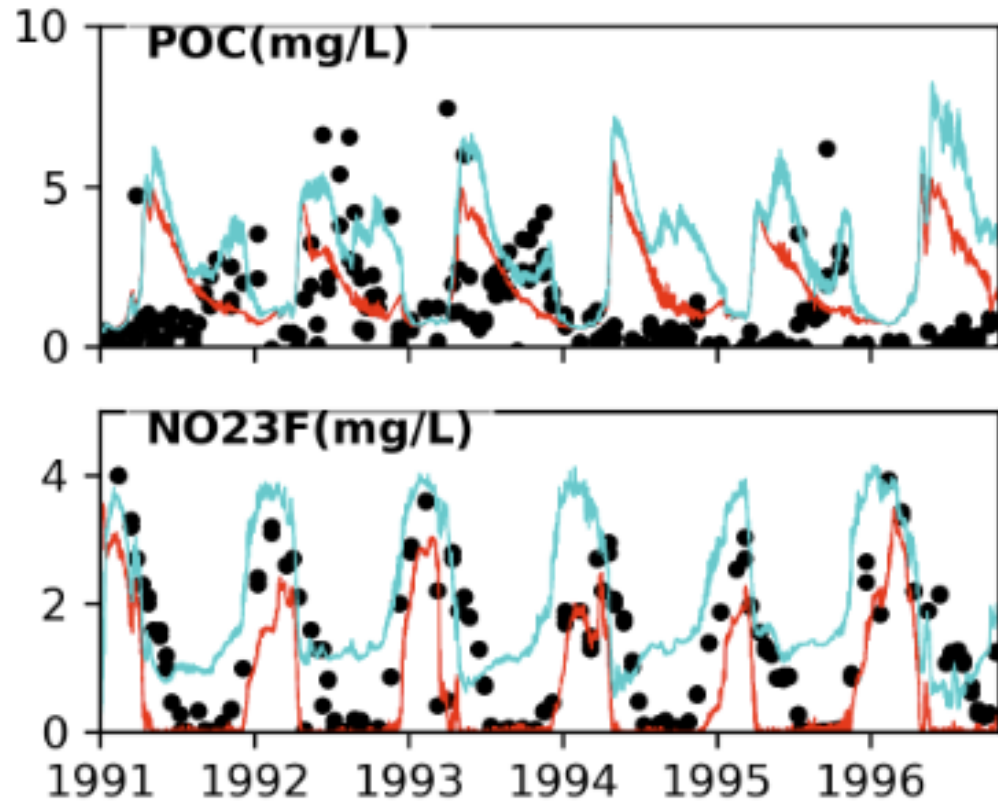
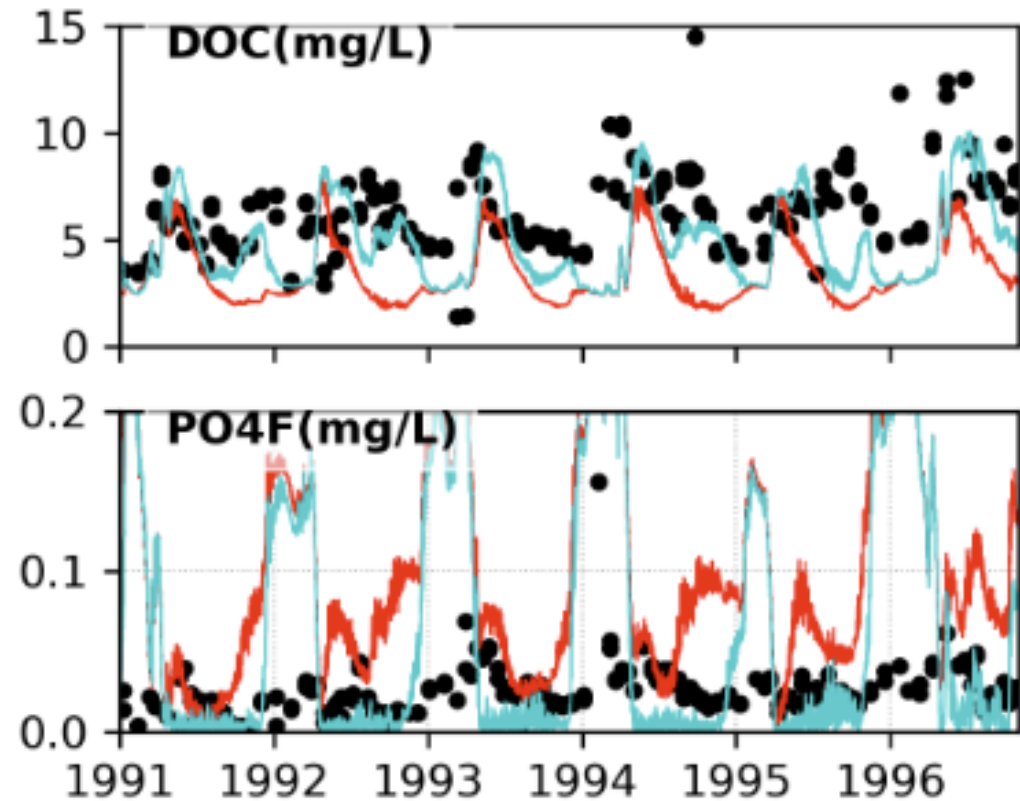


run17c2

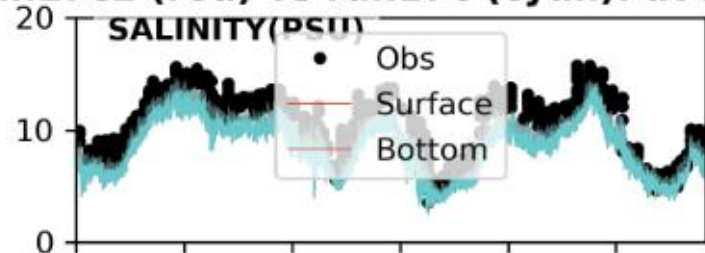
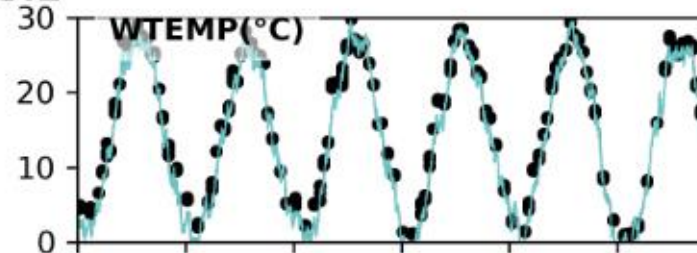
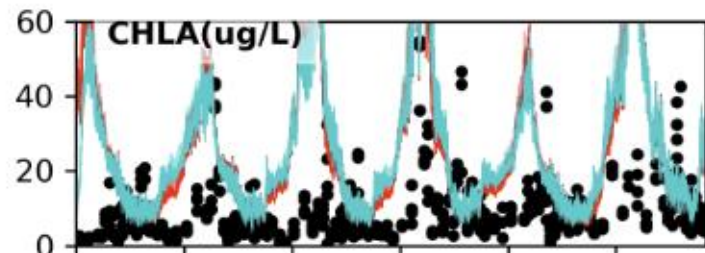
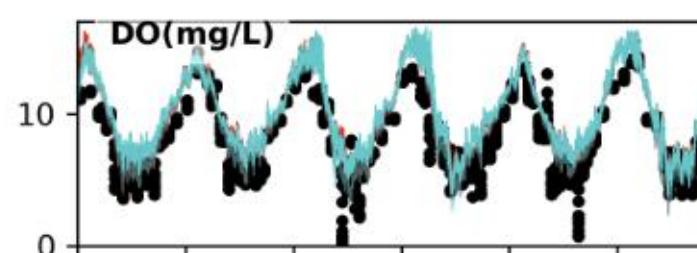
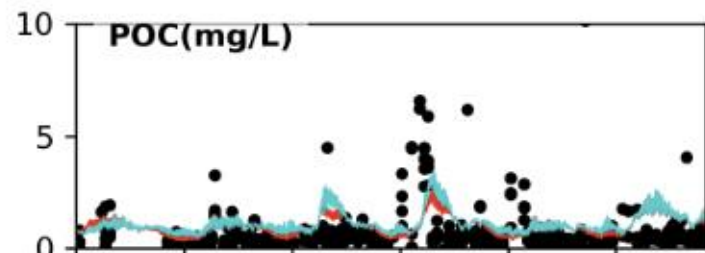
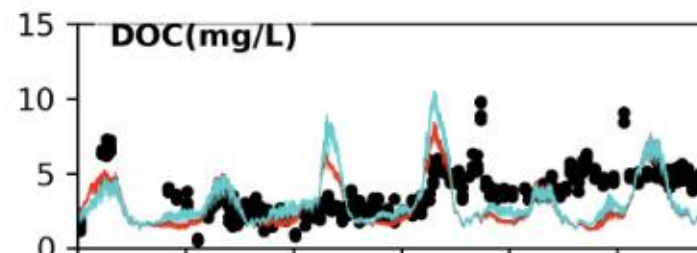
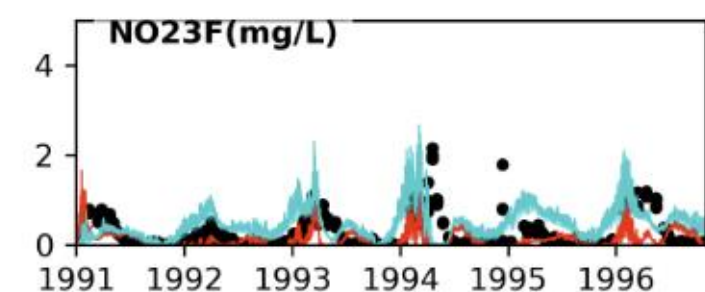
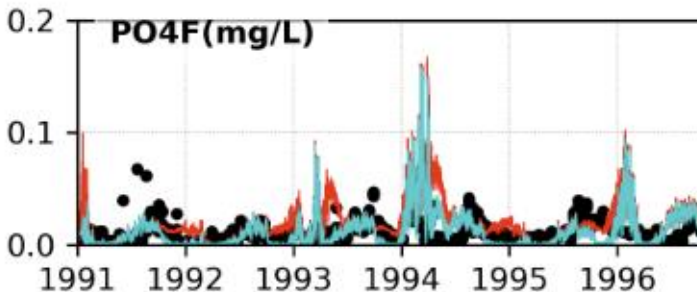


The new model does capture better the zero NO₂3 during the summer.
NO₂3 also shown earlier depletion.

How does that affect other water quality variables? At ET5.1

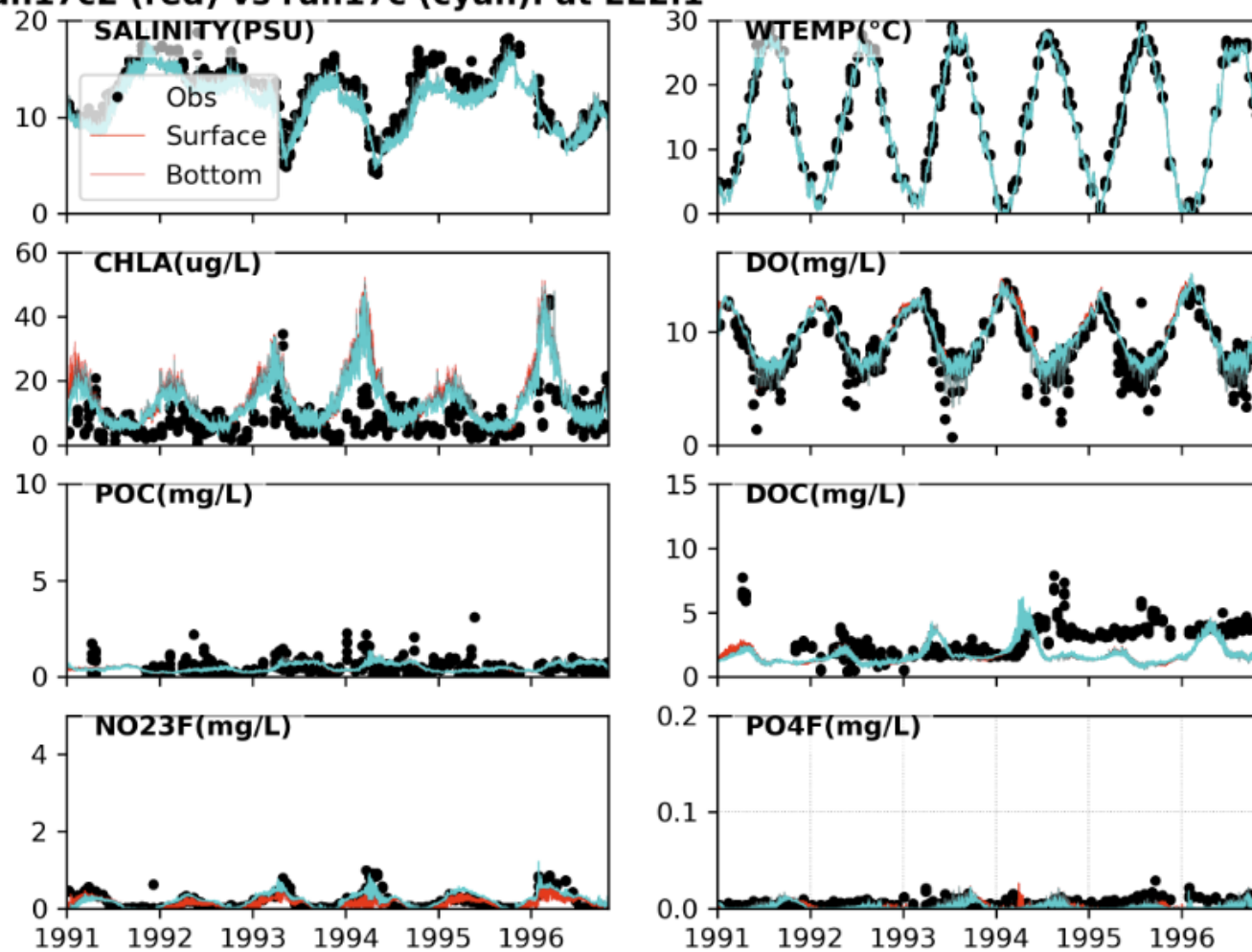


run17c2 (red) vs run17c (cyan): at ET5.2



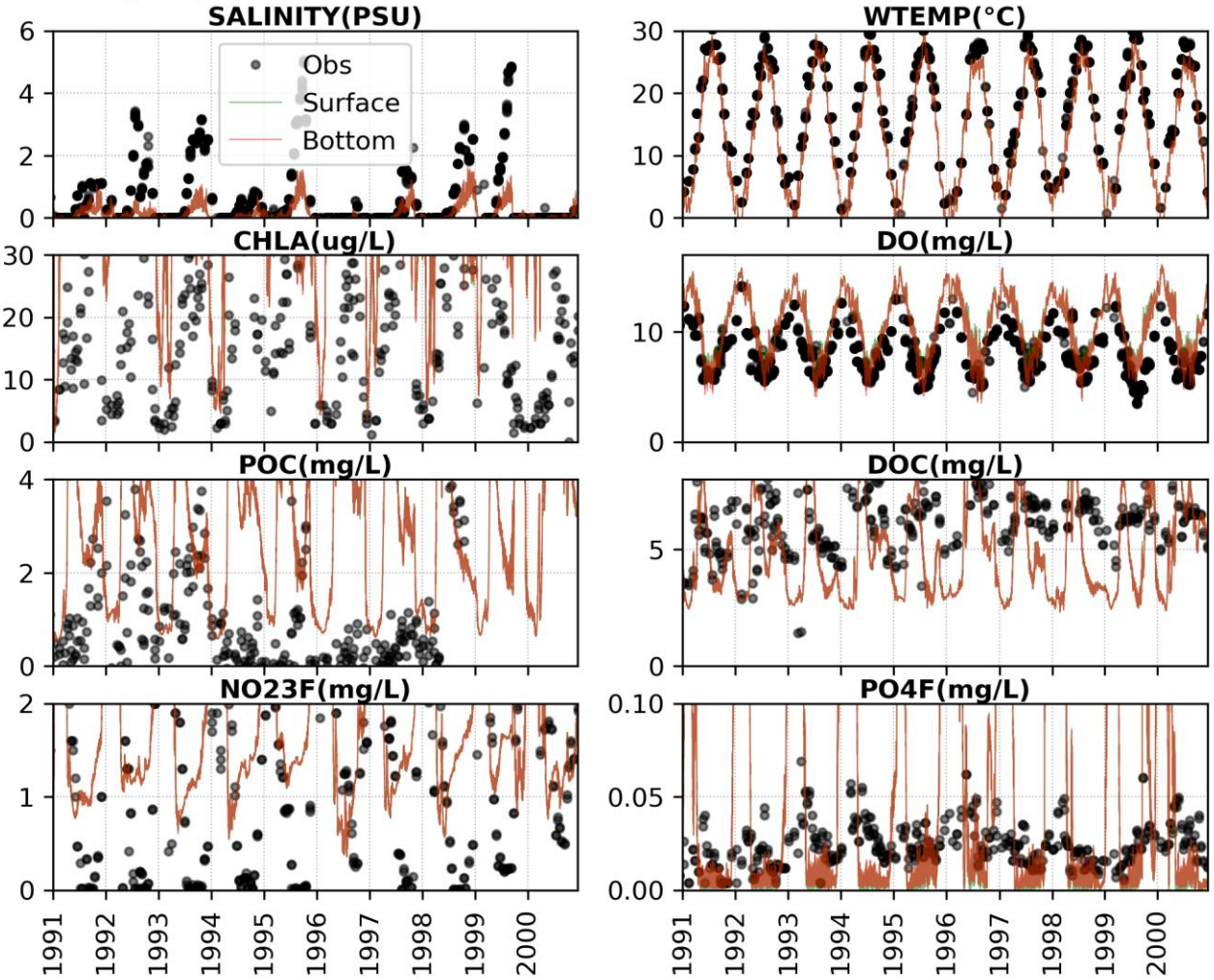
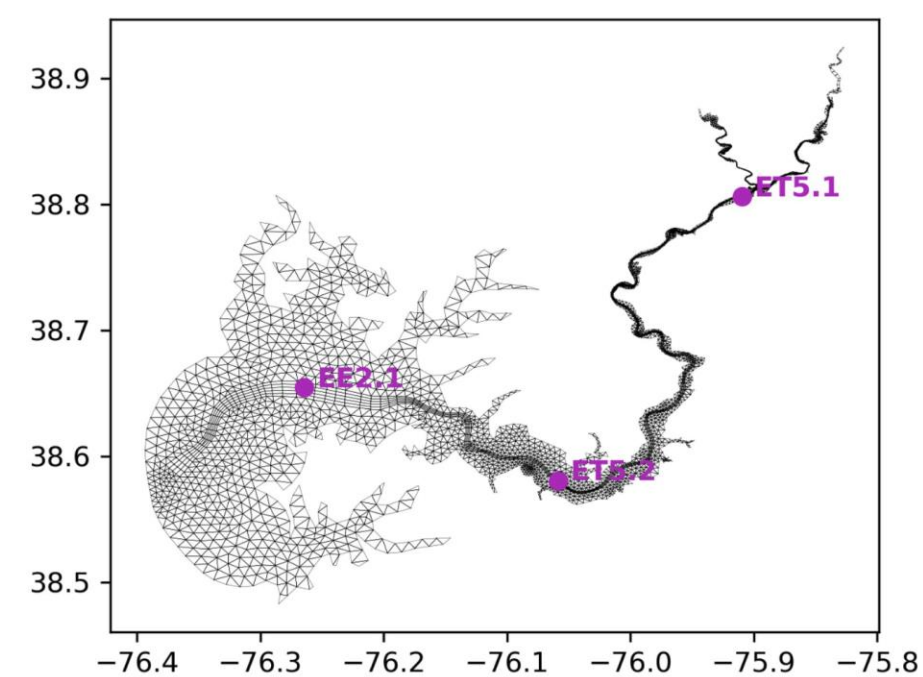
At ET5.2, the impact is little

run17c2 (red) vs run17c (cyan): at EE2.1

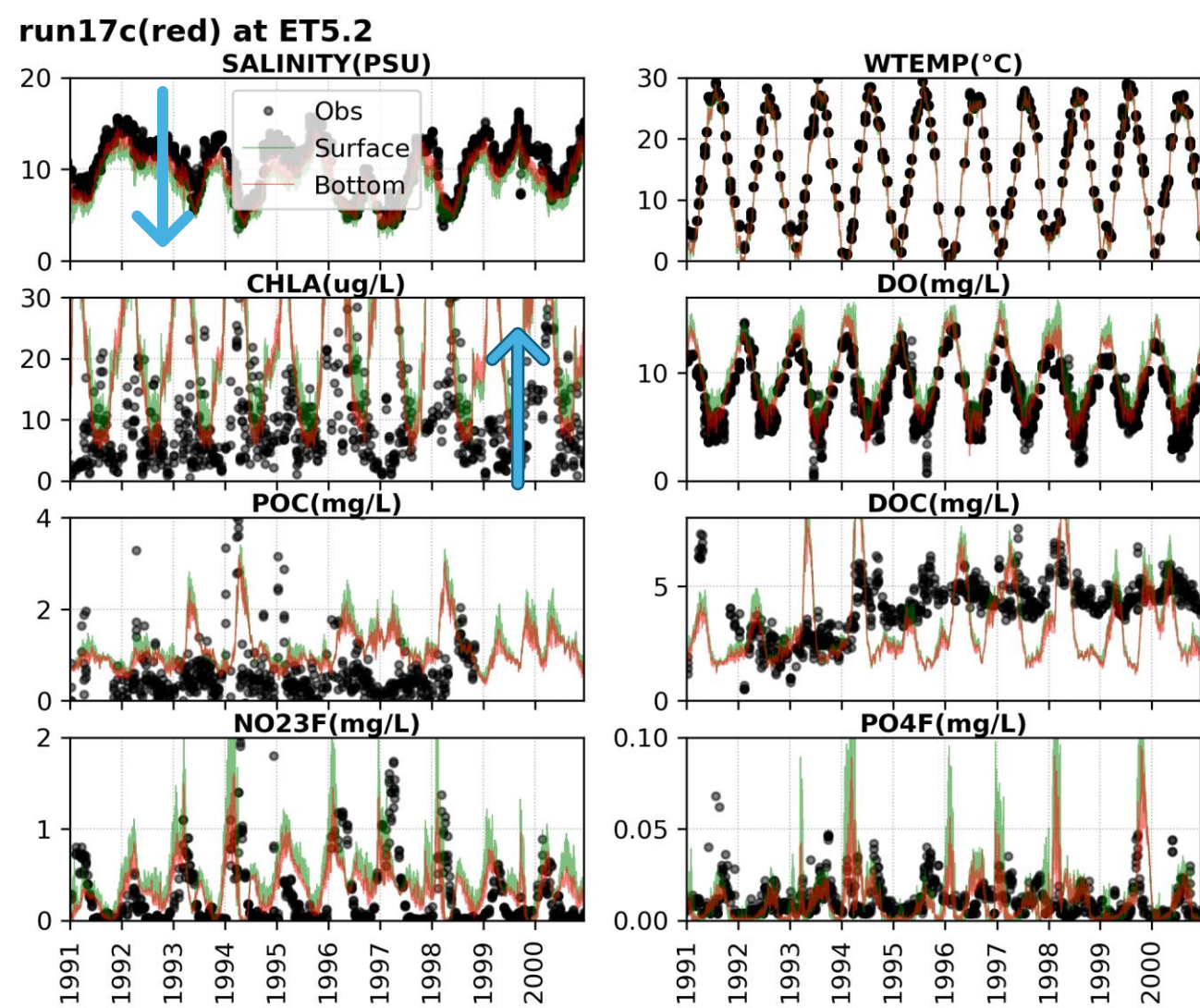
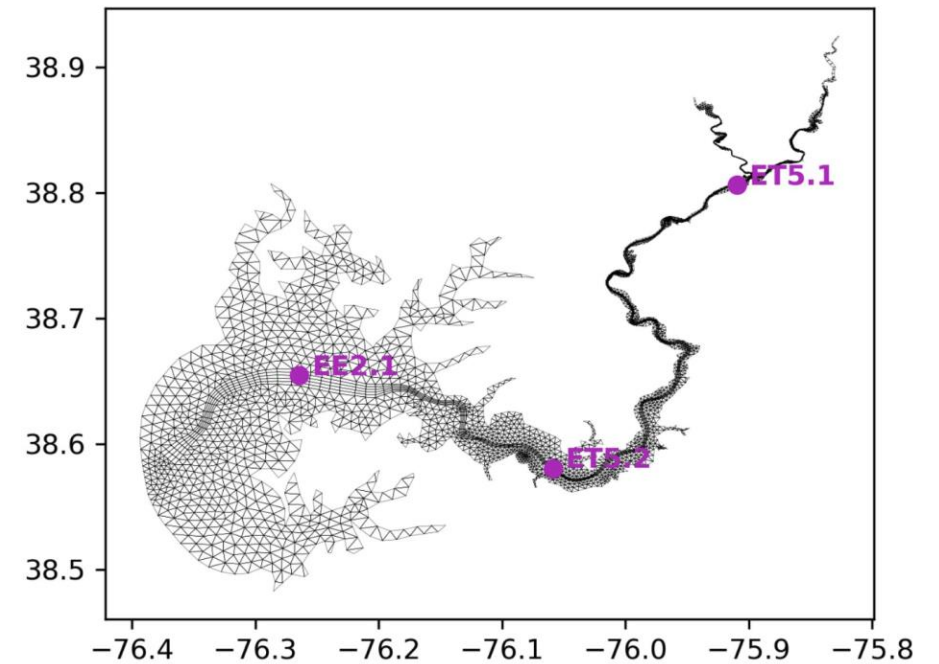


At EE2.1, the impact is negligible

run17c(red) at ET5.1

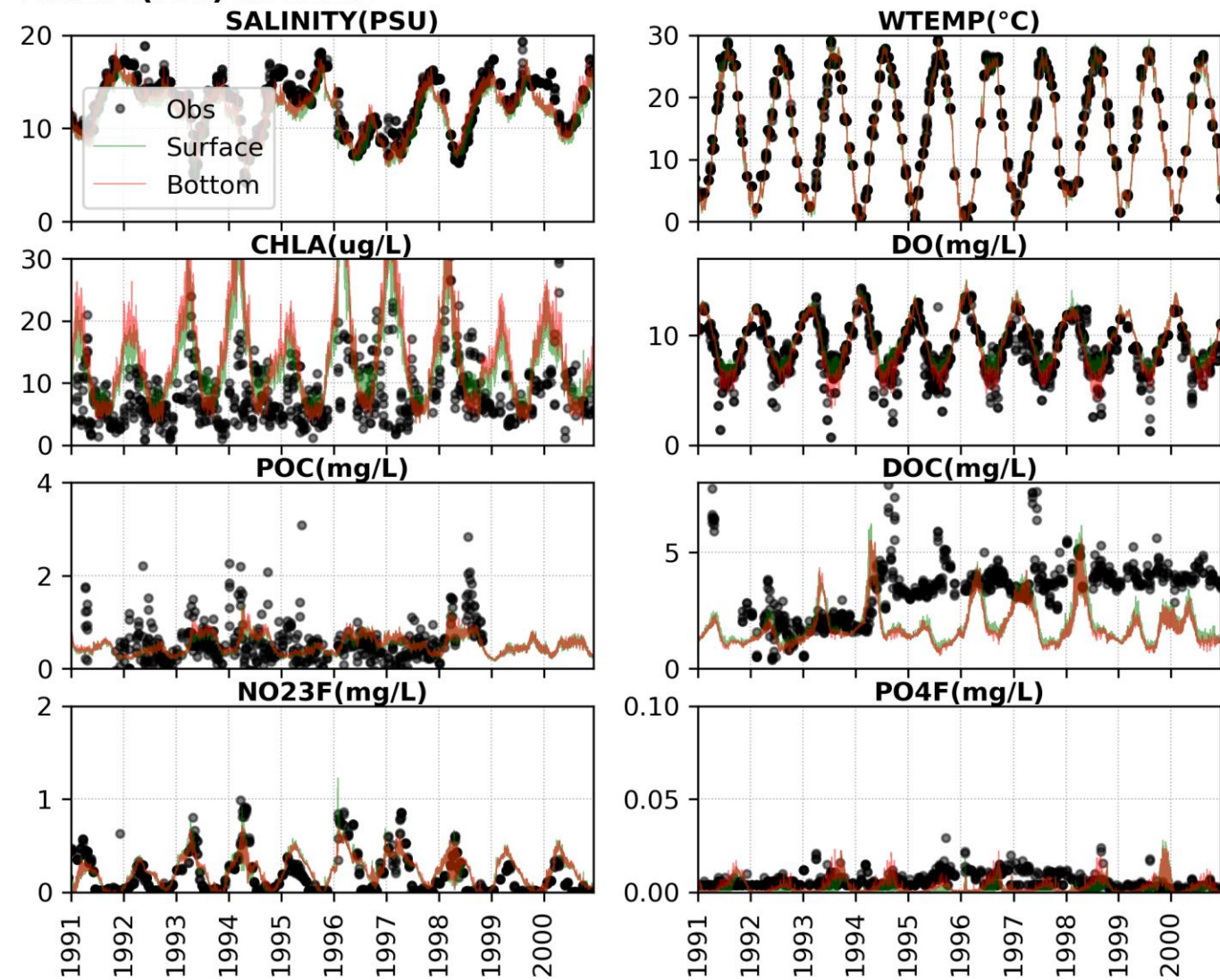
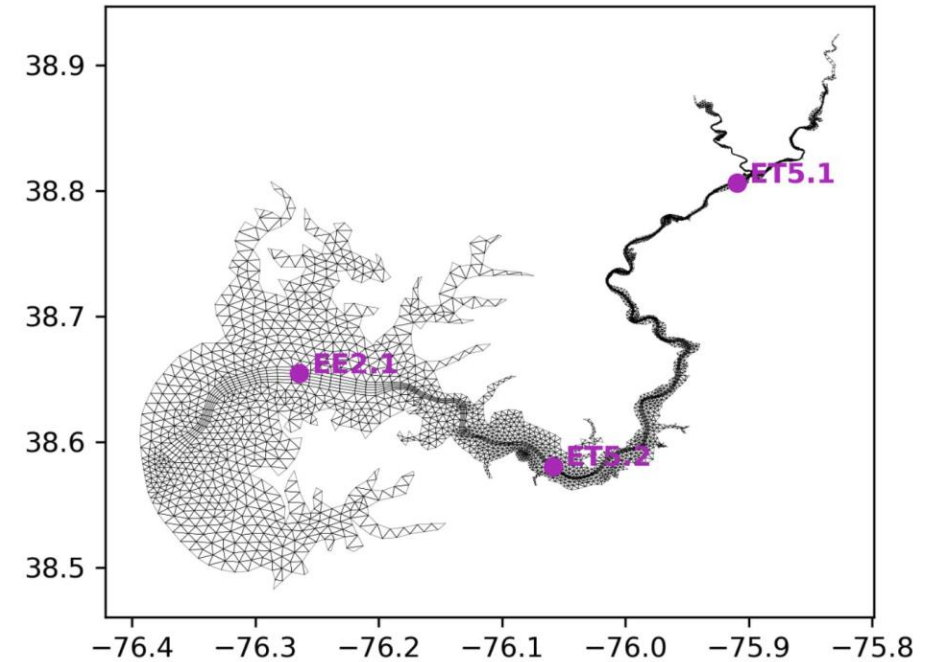


- Underestimated: salinity, PO4F
- Overestimated: Chlorophyll-a, POC, NO23F



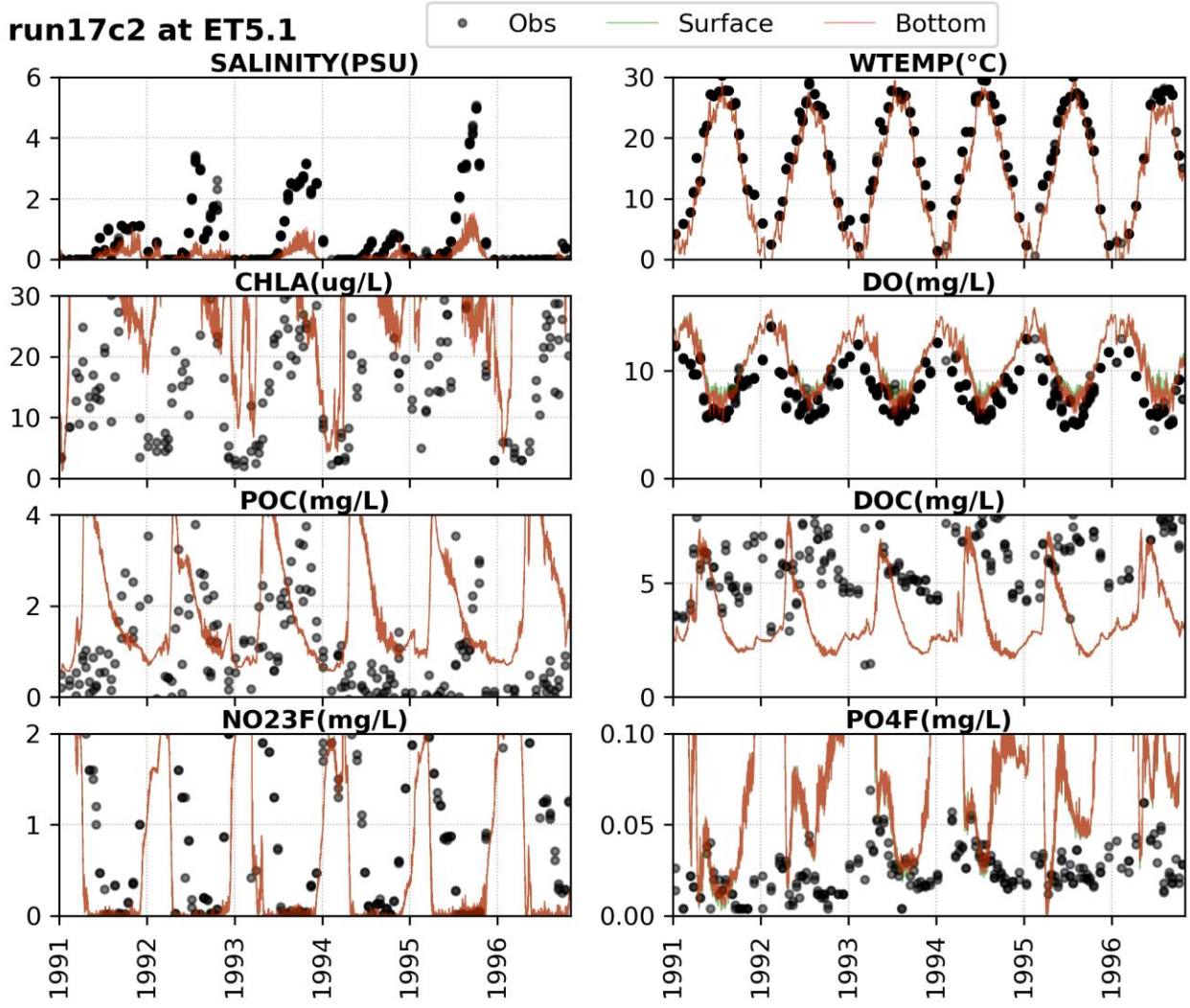
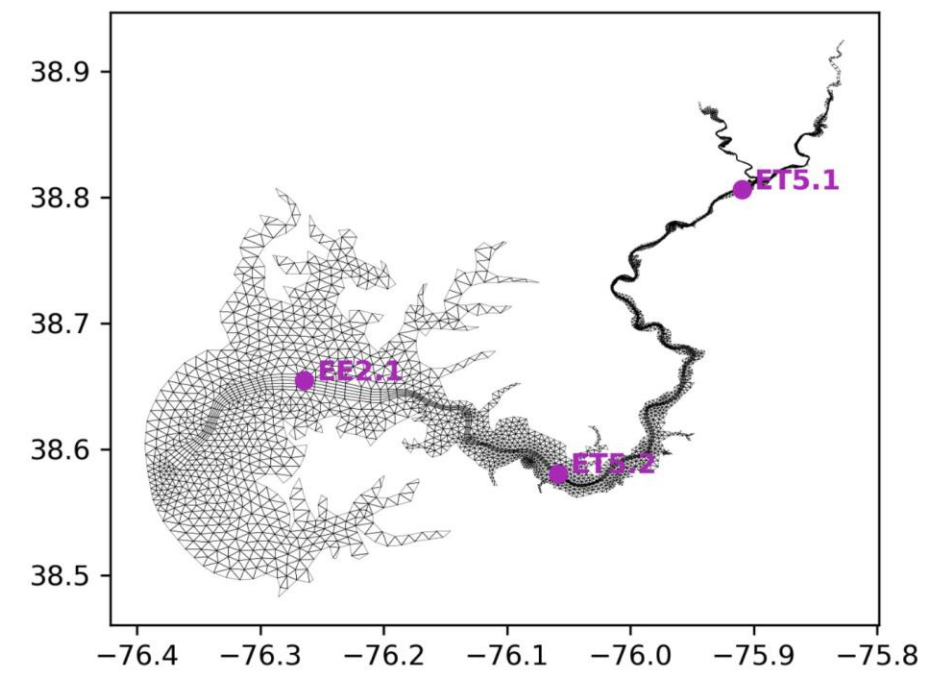
- Underestimated: salinity
- Overestimated: Chl-a
- Low correlation/unmatched: POC, DOC

run17c(red) at EE2.1

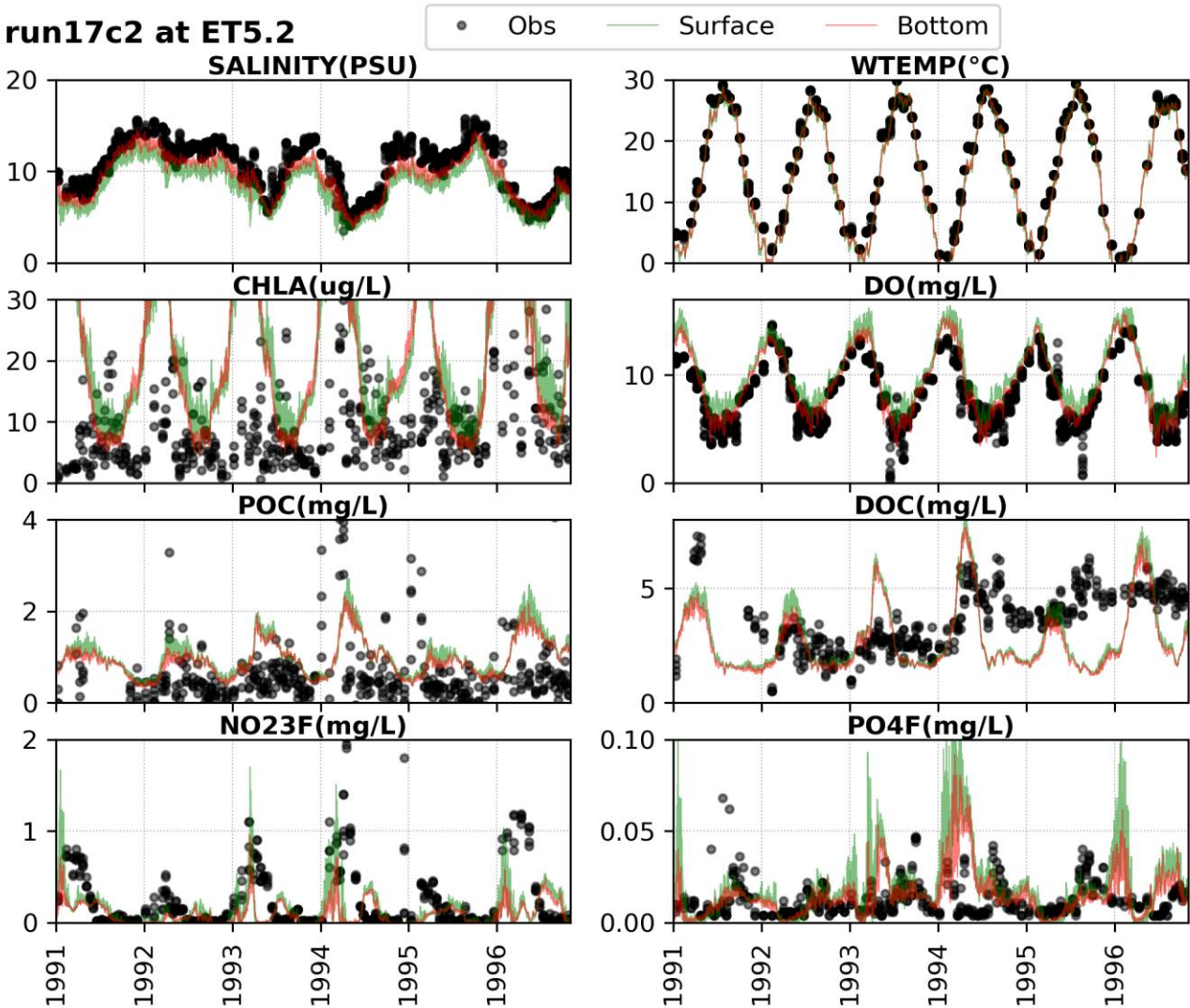
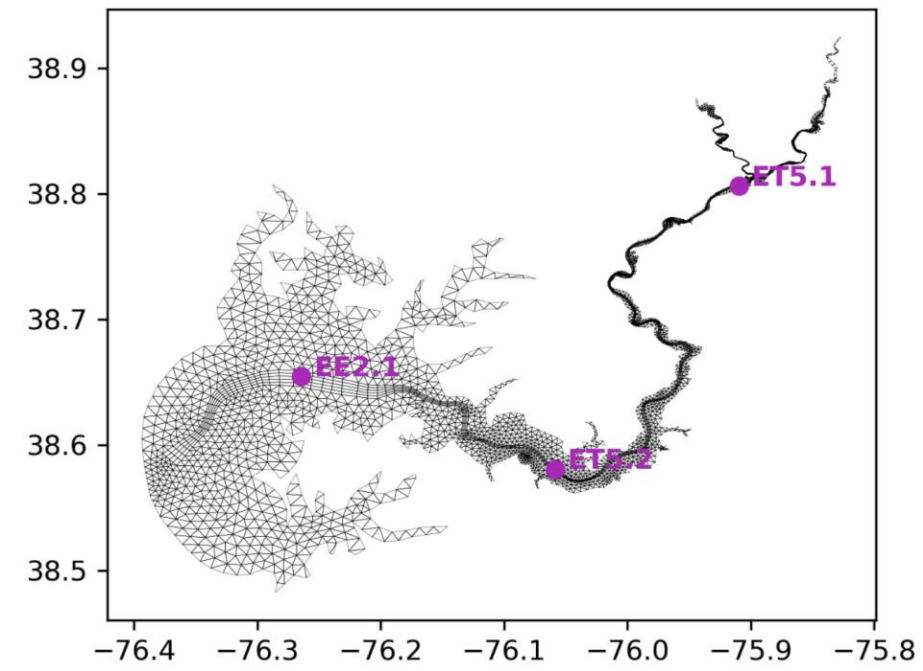
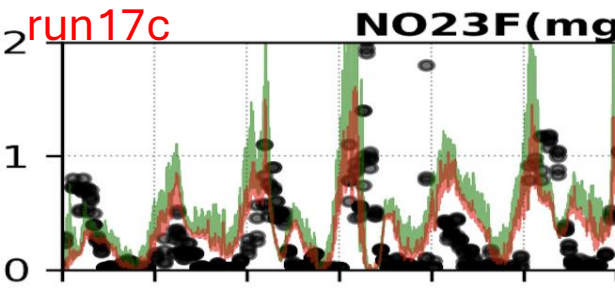


- Low correlation: POC, DOC, Chl-a, PO4F

run17c2 at ET5.1

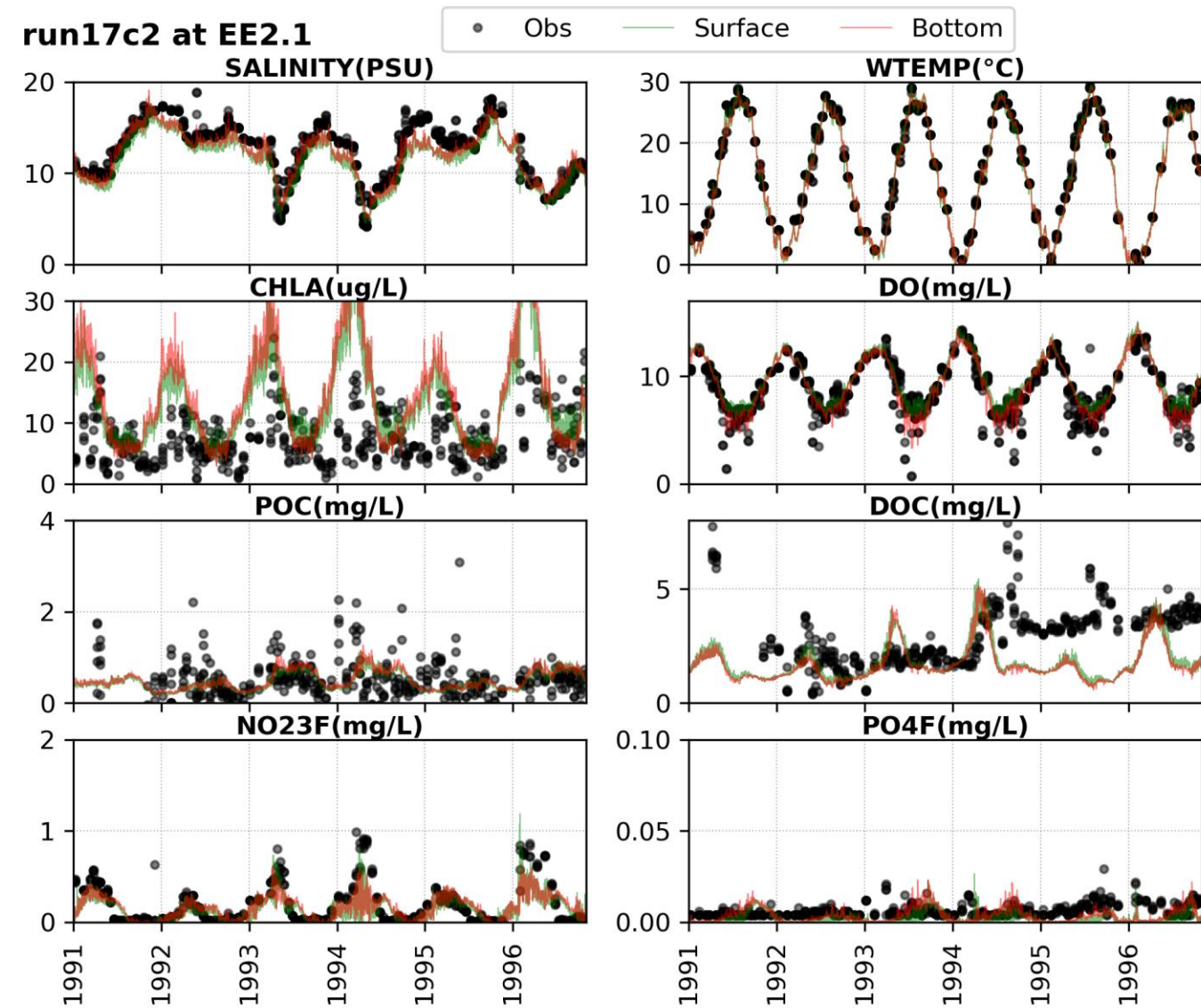
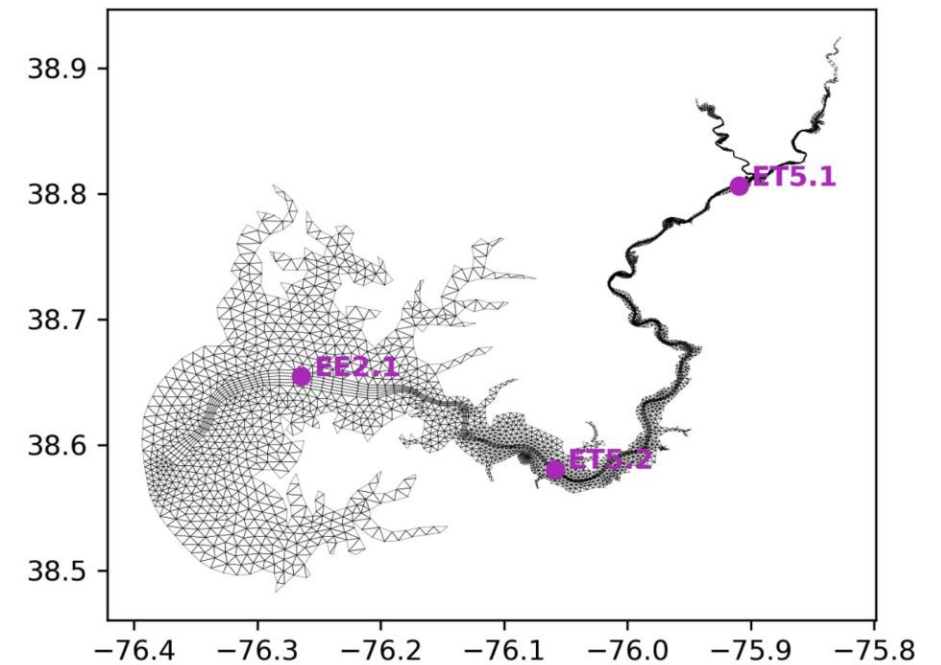


- Improvement on NO23F and PO4F



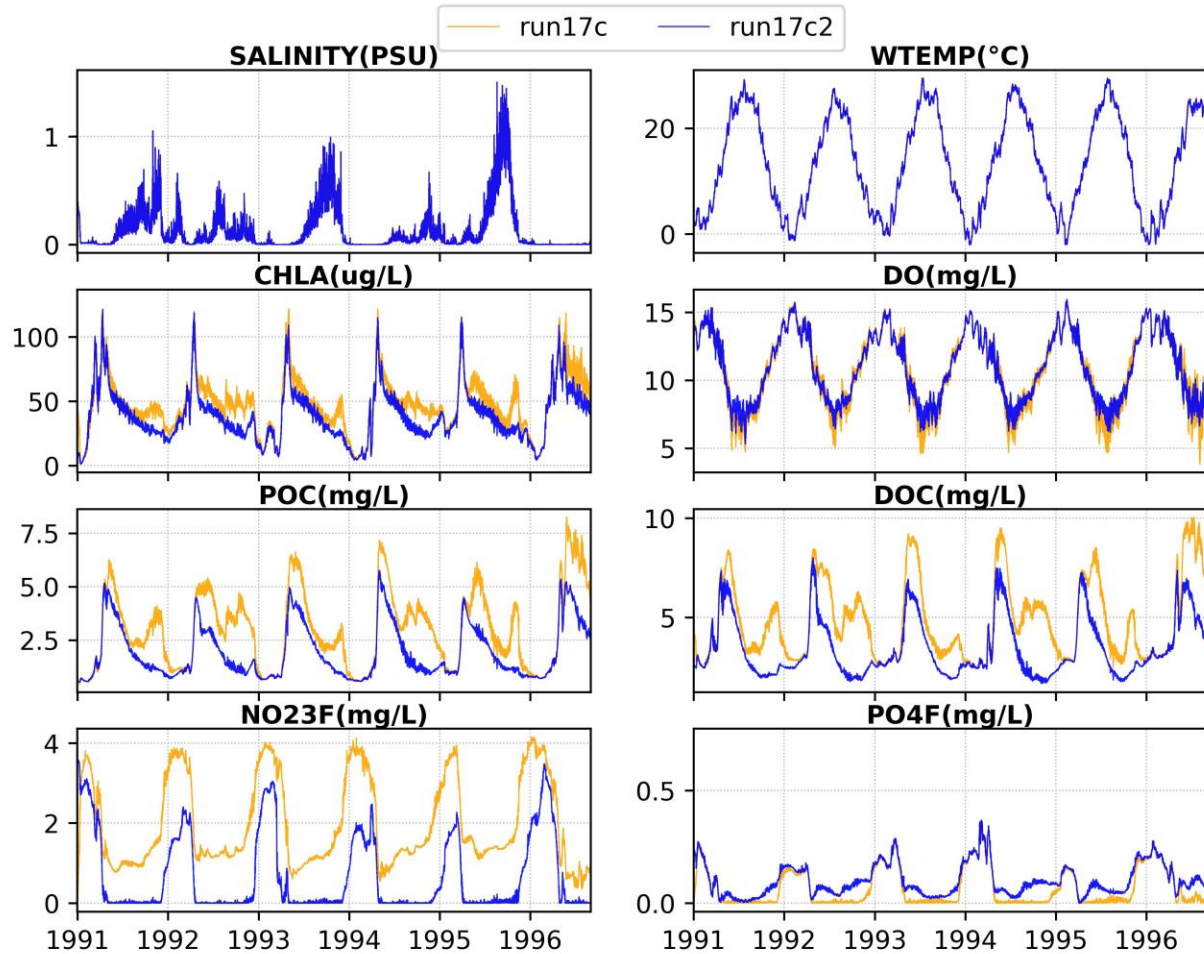
- Limited improvement on NO23F, the impact is little

run17c2 at EE2.1

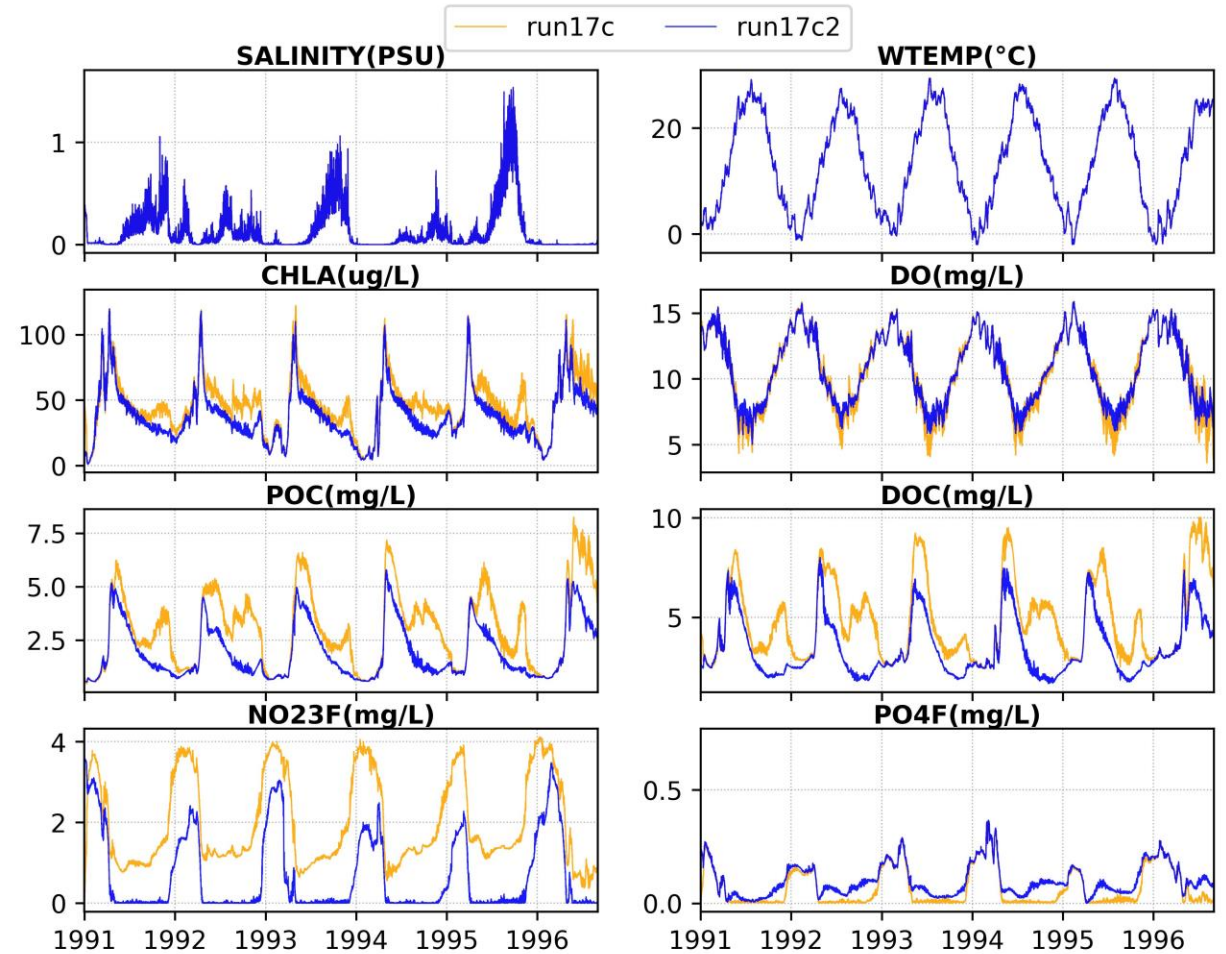


Limited improvement from **run17c**, the impact is little

Surface



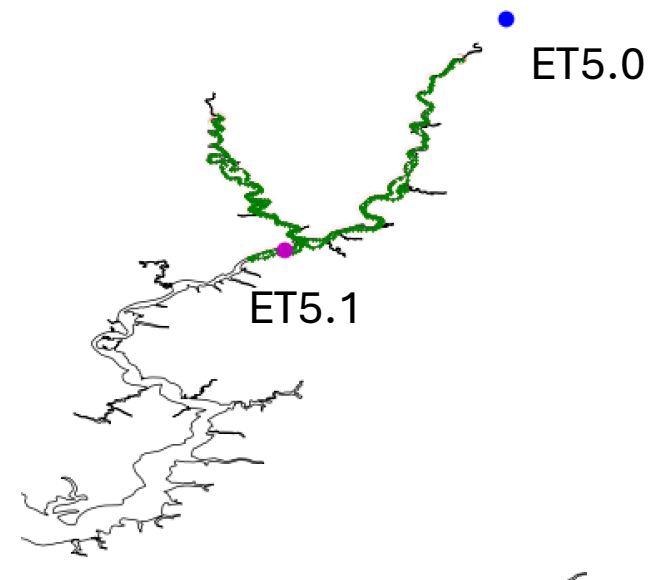
Bottom



Lowered NO23 induces decreased concentration of Chl-a, POC, DOC, increased concentration of PO4.

3 stations, 8 variables, 1 base run and 1 sensitivity test

ET 5.1	Salinity
ET 5.2	Temperature
EE 2.1	Chl-a
	DO
	POC
	DOC
	NO23
	PO4



Using the new *source.nc* to change the NO23 for every station in the upper stream of Choptank

Key takeaways on BGC modelling

- Nutrient input in the upstream matters, but the influence is less in the downstream region.
- It does not mean using observation NO₂₃ is right. We will need efforts to capture the depletion of NO₂₃ during summers.

Future directions

- Resolving the NO₂₃ depletion during summers.
- Testing on other variables, such as PO₄